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The Potato Crop in Alberta

BY

A. W. Henry
Department of Plant Science

It pays to use good seed. Netted Gem potatoes from certified seed grown in central Alberta. Photo by N. N. Bentley.

FACULTY OF AGRICULTURE
UNIVERSITY OF ALBERTA
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by
A. W. Henry

INTRODUCTION

Importance of the Crop

Potatoes are probably grown by more people in Alberta than any other crop, but the total acreage devoted to them is small compared with that sown to cereal crops. In 1943, Alberta had only 31,200 acres in potatoes as compared with 4,829,000 acres in wheat. The importance of the potato crop should however not be measured by the extent of its cultivation alone. Consideration should also be given to its value per acre and to the dependence which we place upon it. More food per acre can be produced from a crop of potatoes than from wheat or from many other crops. The extent of its cultivation, its production and value in Alberta may be judged from the figures in Table I.

TABLE I

Potatoes in Alberta—1941-1945*

Year	Area Acres	Yd. per acre Cwt.	Production Cwt.	Av. Price $ Cwt.	Value $
1941	30,000	65.0	1,950,000	1.03	2,009,000
1942	28,500	95.0	2,708,000	1.15	3,114,000
1943	31,200	69.0	2,153,000	1.60	3,445,000
1944	28,700	75.0	2,153,000	1.47	3,165,000
1945	25,900	60.0	1,554,000	1.94	3,015,000
5-yr. av.	28,860	72.8	2,103,600	1.44	2,950,000

* Figures kindly supplied by Agricultural Extension Service, Alberta Department of Agriculture.

Utilization of Alberta Potatoes

Human Food

Alberta potatoes are used chiefly for human food and most of them are consumed at home. However, a few hundred carloads of table-stock are normally exported annually. But occasionally we find ourselves in the position of having to import table-stock.

Feed for Livestock

Potatoes are used to some extent as feed for livestock in Alberta but not nearly so commonly as they are so utilized in areas which lack our abundant grain supplies. They can be used as a succulent feed for most kinds of livestock but should be supplemented with other feeds and used with caution. For hogs they are best fed after cooking. It would seem that we might advantageously market more of our cull and surplus

potatoes through livestock. It should be noted, however, that potatoes that are frozen, in a sprouting condition or partly rotted should not be fed to livestock. Sprouts should be removed before feeding.

Seed

High quality seed potatoes can be and are being produced in Alberta. At present, however, the quantity of such seed produced annually within the province is relatively small. There is need for considerable seed each year within the province and a greater demand for it might be built up outside. The growing of seed potatoes is not an enterprise which should be undertaken by persons who are not prepared to give to it the special care and attention which it requires, but there is room for more potato seed growers of the right type in Alberta.

Special Products

The local production of special products such as starch, glucose and alcohol from Alberta potatoes must await the establishment of processing factories here. Dehydrated potatoes have already been processed from potatoes grown in the irrigated district around Lethbridge and it may be that in time one or more starch factories or other processing plants will find a place in the irrigated areas of our province. It would seem that the more we can utilize the potato for the production of such processed products the better, since one of the main handicaps which we have in potato production in Alberta is the high cost of transportation to large markets.

Adaptation of the Crop

The fact that potatoes are grown successfully in most parts of Alberta indicates that the crop is reasonably well adapted to climatic and soil conditions here. They of course do better in some parts of the province than in others.

Potatoes require considerable moisture especially during the tuber-formation period. This largely explains why the best yields are obtained in the park belt and in the irrigated areas as compared with the drier open plains region. The temperature factor is also important and again especially so during the tuber-forming period. Moderately cool weather favours the potato during this period, while hot weather is detrimental. Low temperature at the end of the season is probably the most serious limiting factor so far as temperature is concerned, but the danger of fall frosts is by no means sufficient to exclude the crop even in the extreme north.

Soil conditions also influence both yield and quality. Much of the soil in Alberta is suitable for potato production though

some of our soils are much better than others. Among the less favourable types are the very heavy soils, the very light soils, shallow soils, the very alkaline soils and the low-lying soils subject to flooding. The deep easily worked loam soils usually produce the best crops of potatoes assuming of course favourable climatic conditions. Careful soil management, however, is necessary for best results with potatoes and this applies particularly to the less fertile ones such as gray soils and the more extreme types.

CHARACTERISTICS AND CLASSIFICATION

The Potato Plant

The potato, though not cultivated as a perennial can live from one season to the next by means of its tubers. This occurs most readily in regions of mild winters but it does occur on occasion even in Alberta, for instance, in years when a good snow cover comes early and is maintained during the winter period.

Leaves and Stems

The above-ground parts consisting of rather large compound leaves and thick juicy erect stems rarely exceeding 2-3 feet in height, are not useful even as feed for livestock, but they are essential to the development of the plant, including the tubers. If the tops are cut off, destroyed by insects, stunted by disease or otherwise damaged, the development of the tubers is almost certain to be adversely affected. This is indicated by the figures in Table II which show the relative yields of adjacent potato plants, one of each pair of which was left to develop normally while the upper half of the other was cut off. The comparison was made during the summer of 1940. By August 1 the tubers were about the size of hens' eggs. On this date approximately one-quarter of the top of every other plant was cut off and on August 6 another quarter of each of these same plants was removed leaving about one-half of the top of each decapitated plant remaining. It is evident from Table II that partial removal of potato tops during tuber formation may greatly reduce tuber yield.

TABLE II

Effect of Cutting-Back Potato Tops on Tuber Yield

Pair No.	Yield in ounces per plant		Reduction from cutting
	Uncut	Cut	
1	76	24	52
2	42	35	8
3	61	27	34
4	49	41	8
5	74	30	44
6	38	20	18
7	85	16	69
8	77	17	60
9	67	19	48
10	38	23	15
Average of 10 plants			
(Ounces per plant)	61	25	36
(Bushels per acre)	688	285	403

Both the leaves and the aerial stems are naturally green or nearly so, though in some varieties the presence of a certain amount of color may be quite normal. On the other hand mottling, purpling or yellowing of the foliage may be evidence of disease and consequently should be taken as a warning by the grower.

Potato plants showing characteristic leaves and fruits. After O. S. Aamodt.

Flowers, Fruits and Seeds

Another part of the potato tuber which is also used very little or not at all by the average grower is the flowering part. Generally speaking, the potato flower is given only passing attention by the public, but the flower color and certain other features of it are useful in distinguishing varieties and the plant breeder is much concerned with this part of the plant and with the fruit and seed which arise from it. The potato plant forms its flowers in groups of five to ten at the top of the plant. The individual flower is fairly large and usually whitish, bluish or purplish in color. The fruit is a greenish berry resembling a small tomato. It is divided into two fleshy

halves, each containing numerous small kidney-shaped seeds. Seed setting in the potato does not, however, always take place. Much infertility in fact occurs, and this increases the difficulties of the plant breeder in his attempts to produce new varieties. Poor pollen and the tendency for flower buds to drop prematurely are two of the most common causes of poor seed setting in the potato.

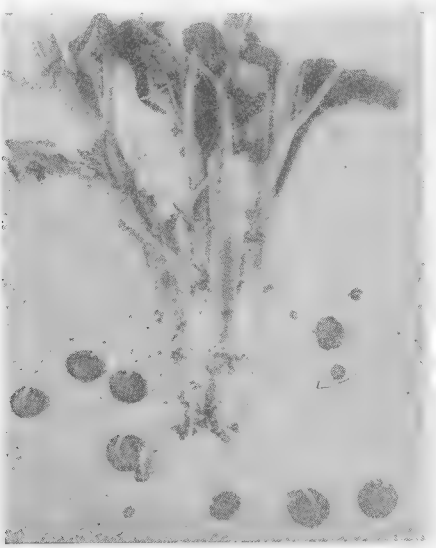
Varieties differ widely in ability to set seed. Environmental conditions also influence seed setting. When good seed is obtained it may be used to produce new plants but not for general culture. The seedlings arising from seeds are rather delicate plants and are not very productive. They may be, however, very useful to the plant breeder as will be pointed out later.

Potato plant (left) grown from a tuber (set) and one (right) grown from a seed. Note spindly growth of the seedling. A sample of true potato seed is shown on the blotter between the pots. After O. S. Aamodt.

Roots and Underground Stems

The underground part of the potato plant may be divided into two main parts, the underground stems and the roots. In seedling potatoes the roots consist of a large main tap root

and numerous fine laterals branching from it. The roots of the potato as it is ordinarily grown from sets, consist of a fibrous mass originating from the main stem just above the set. The roots of the potato as is the case in all plants, are very important organs by means of which nutrients and water are gathered from the soil. Besides roots, modified stems or rhizomes also arise from the basal parts of the ordinary stems below ground. The tips of the rhizomes form the tubers. Tubers are, consequently, merely swollen portions of the



Formation of potato tubers at the tips of the underground stems or rhizomes. After W. C. Amundson et al.

underground stems and naturally have the structure of a stem rather than that of a root. It is especially important that these underground parts of the plant have ample room and other necessary conditions for their development in the soil.

Tubers

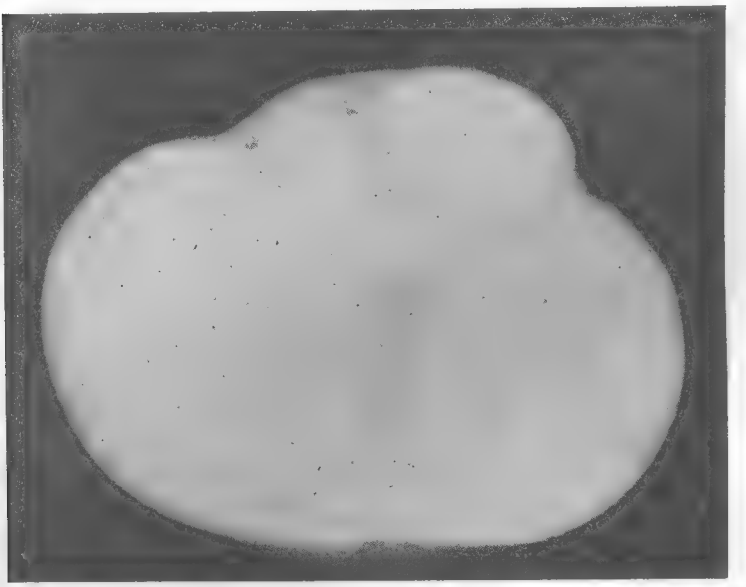
The tubers constitute the most valuable part of the potato plant, the chief commercial product and the chief means by which it is commonly reproduced. We therefore have reason to give special consideration to them.

The outer layers of the potato tuber form what is popularly known as the skin. They are corky in nature and protect the inner parts from injury. If the skin is broken as it often is in handling, there is always danger of decay occurring in the exposed tissues. By the formation of wound cork the exposed tissues are fortunately able to protect themselves again in a

few hours. It is nevertheless wise to handle potatoes so that they will be injured as little as possible rather than depend too much on such natural healing processes. The color of the skin of potatoes varies with the variety and is of some value in distinguishing them. However, many varieties have white or yellowish skins, since this color is most popular on the market. Red or pink skinned varieties are fairly common but bluish or purplish skinned ones are quite rare. Tubers of some varieties vary in color in different parts of the same tuber. For instance, some have white skins and pinkish eyes. The majority of potato varieties have smooth skins but a number of popular ones with rough and netted skins are now grown. Thickness of the skin also varies somewhat with the variety. The so-called eyes of the potato tuber consist of small clusters of buds arranged in and around depressions on the surface. A line marking the position of each eye is usually present at the margin of the depression and is commonly referred to as the eyebrow. At the seed-end of the tuber the eyes are more numerous than at the other end which is called the stem-end where the tuber is attached to the rhizome. Tiny whitish lens-shaped specks may also be observed on the surface of the tubers. These are known as lenticels or breathing pores. In very wet soil they may stand out prominently as whitish blisters.

The interior of the tuber may be divided first into two main zones, an outer narrow band about ¼ inch in width at its widest points and a large central part making up the rest of the tuber. Separating these two areas is a fine threadlike line known as the vascular ring. This contains conducting tissues which approach the surface of the tuber at the eyes. It is not very conspicuous but can be distinguished with the naked eye if a thin slice representing a cross-section of the tuber is held to the light. The part of the tuber outside the vascular ring is known as the cortex while that inside the ring is known as the medulla or pith. Both parts are made up of thin-walled cells containing numerous starch grains. The densest part of the tuber is that which surrounds the vascular ring. This is the most valuable part of the tuber and should be saved if at all possible. For instance, in preparing potatoes for the table, thick peeling should be avoided in order that this valuable part of it may not be removed and wasted. Deep eyes and wounds in the tubers often necessitate deep peeling and consequently are undesirable.

Most varieties grown on this continent have white or nearly white flesh. Yellow-fleshed varieties are in demand in parts of Europe and in South America, but have not assumed much importance here. Departures from a uniform flesh color



Cross-section of a potato tuber showing its internal structure. After J. S. Cobb.

are not uncommon in certain potato varieties but in general are undesirable. The occurrence of streaks and flecks of color such as those which are often seen in the flesh of colored varieties may not be serious but the presence of brown, black and other discolorations often resulting from disease, frost, etc. may seriously affect the value of the tubers both for food and for seed.

Composition and Food Value

Since the potato is grown for its tubers only and since these are used principally for food, it is important to examine the composition of potato tubers particularly from the standpoint of their nutritional value.

The composition of raw potato tubers varies somewhat with the variety, maturity and the environment, but the general composition may be judged from the results of the following analysis: water 78.8, protein 2.2, carbohydrates 17.6, fat 0.1, and ash 1.0. The potato is a starchy, energy-supplying food, starch making up most of the carbohydrate content. The protein content is low, though reported to be good in quality. Potatoes are low in fat and in minerals, particularly in calcium. As to vitamin content they contain appreciable amounts of vitamin C and vitamins of the B-complex but are low in vitamin A.

Though the potato is one of our major food plants it does not alone provide a well-balanced diet. Rations either for men or domestic animals, which include potatoes as a main item, should be supplemented by foods containing proteins and other constituents in which potatoes are deficient.

Propagation of Potatoes

The potato ordinarily is propagated vegetatively from tubers or portions of tubers produced the previous year. It may be compared therefore to a geranium plant grown from a cutting. Vegetative reproduction has both advantages and disadvantages. In the case of the potato it gives a more vigorous progeny than would be obtained were seed propagation employed. It is much easier to maintain purity of the stock when vegetative propagation is practised, but unfortunately certain disease-producing contaminants that may be present in the stock are readily perpetuated by this method of propagation. This latter tendency introduces one of the most serious handicaps to the potato-growing industry.

The propagation of potatoes from seed has little interest for the practical grower, but as has been indicated elsewhere, it is of great importance to the plant breeder and to those engaged in certain other types of potato research work.

Since in propagating from sets, that is, from whole tubers or pieces of tubers, the new shoots arise from buds in the eyes, it is important that each set bear at least one or preferably two or three good eyes. Buds should be alive and capable of producing strong vigorous sprouts. If there is reason to suspect injury from frost, disease or other adverse factors, a representative sample of one's seed should be tested for viability before planting time. It is of course necessary to wait until the tubers have passed through their dormant period. This varies in length with different varieties, but is usually over by mid-winter. In regions such as Alberta the dormant period is well past by planting time. If it should be necessary to germinate potato tubers before the rest period is over, as in some types of testing or experimental work, dormancy may be broken artificially by treatment with certain chemicals such as acetylene.

Seed potatoes should not be allowed to sprout in storage. They should be removed from cold storage two to four weeks before planting. Where possible they should be kept during this period in a moderately warm, light place and allowed to sprout slightly. This will often induce an earlier and better crop.

At this point brief references should be made to the use of "potato eyes" for propagation purposes. The commercial

"potato eye" consists simply of a small portion of the tuber bearing a single eye, scooped out with an instrument known as a baller. Such eyes are used in the same way as potato sets. Hence propagation by this method is a type of vegetative propagation. Its chief advantages are: first, more economical use of seed stocks and secondly, lower cost of shipment to distant points. This method of propagation is not used ordinarily because larger yields are usually obtainable from ordinary sets. One can advantageously make use of potato eyes to get started in good seed. It is well, however, to be sure of the quality of the seed, for example, its freedom from disease. Distributors of potato eyes should be particularly careful to see that parental stocks are free from disease.* They should also be careful to prepare the eyes for shipment in such a way that they will not deteriorate before they reach the purchaser and before he is in a position to plant them.

Quality in Potatoes

The meaning of quality as applied to potatoes varies with the use to which they are put. Since potatoes are used largely for human food on this continent, cooking quality is commonly signified when referring to potato quality. Here again the term may vary in meaning with the form in which the potato is prepared for food. However, cooking quality is according to our standards usually considered to be indicated by mealiness, white color, and good flavour after boiling, while sogginess, dark color, and strong or insipid flavour denote poor quality. For potato chips and other forms of food made from the potato, quality may be judged by different standards. Cooking quality varies with the variety and is influenced by such factors as soil, climate, age and storage.

The term quality may also signify market quality or grade which is determined in the case of table-stock by such characters as size, shape, uniformity, color, cleanliness and freedom from blemishes and in the case of seed-stock by additional characters such as purity of variety, vigor and freedom from disease judged both on the appearance of the tubers and on that of the plants which produced them.

Relationships of the Potato

The potato is a member of the Nightshade or Solanaceae family. In this same family are to be found other cultivated plants such as: the tomato, tobacco and pepper. Each of these plants represents a distinct group or genus of the family. Thus the potato belongs to the genus *Solanum*. Each genus is further divided into species. The potato has been given the

*Dominion law requires that "potato eyes" now offered for sale for seed be obtained from certified seed.

species name *tuberosum*. Its complete name is *Solanum tuberosum* meaning tuber-bearing *Solanum*. There are several hundred other species of *Solanum* only a few of which produce tubers. The potato is the most useful species. Certain other species of *Solanum* have in recent years been found to have considerable incidental value as parents in hybridization work employed in attempts to improve the potato, eg., *Solanum demissum* and *Solanum andigenum*.

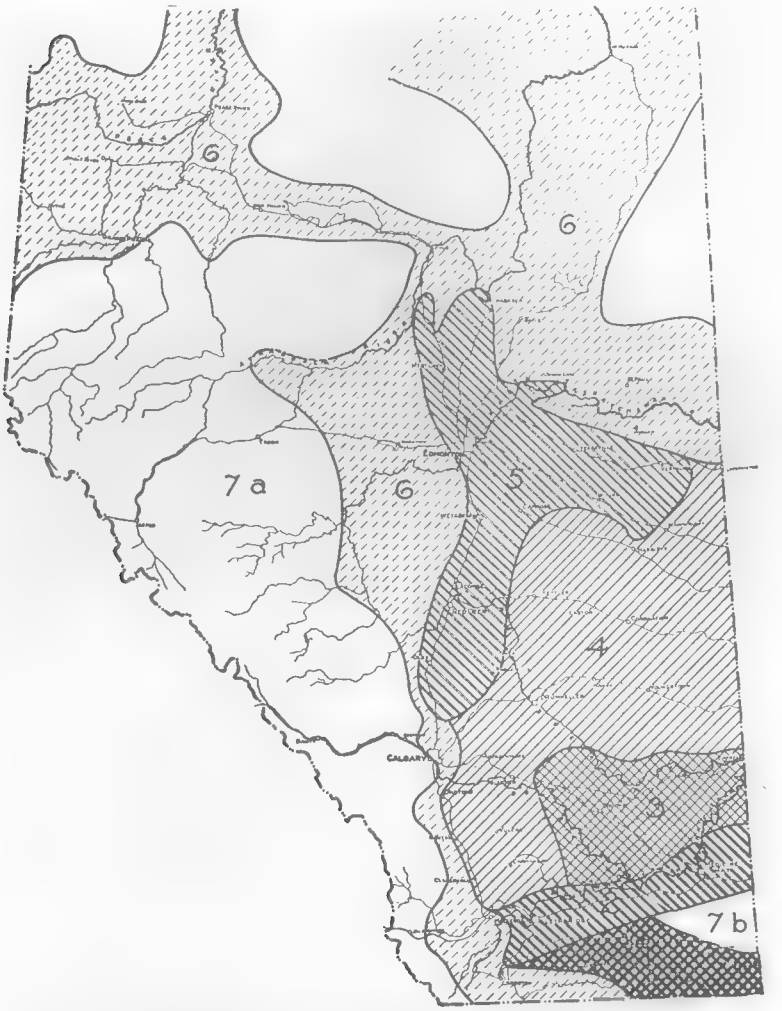
Potato Varieties

Distinguishing Varieties

Since its introduction to other parts of the world from its original home in South America, the common potato has been subjected to much improvement by breeding. A considerable expansion in the breeding of new varieties has taken place just recently. As a result the common potato is now represented by many different varieties. These have certain characteristics in common so that we recognize them all as potatoes, but they differ in other characters especially in tuber peculiarities and in physiological characters such as earliness, disease reaction and yielding ability. In classifying or in distinguishing potato varieties we rely to a large extent on differences in the tubers, eg., in their shape, color, smoothness etc., and usually to a lesser extent on certain plant characters such as flower color, sprout color, leaf shape, etc. There are now many hundreds of potato varieties, and no one classification covers all of them. A publication issued in April, 1946, by C. F. Clark and P. M. Lombard, namely Circular 741 of the United States Department of Agriculture describes and provides a key for the identification of numerous American potato varieties. An older publication from the same source by William Stuart, namely Bulletin 176, contains additional descriptive material on American varieties.

Potato Varieties in Alberta

Alberta is a large province embracing a wide variety of soil and climatic conditions. It would hardly be expected that any one variety would be best for all districts. Some varieties are more widely adapted than others. On the basis of information available at present, it is not possible to rate many of our potato varieties according to their relative yielding ability and general suitability for all districts in Alberta. However, the following are considered satisfactory by the Alberta Horticultural Advisory Committee in one or more districts of the province—late varieties: Netted Gem and Wee MacGregor; midseason varieties: Early Ohio, Cobbler, and Bliss Triumph; early varieties: Carter's Early Favourite, Warba, Vick's Early, and Early Epicure.



Map of Alberta showing the relative suitability of different districts for different varieties of potatoes. After the Alberta Horticultural Advisory Committee.

Potato Varieties	Districts						
	1	2	3	4	5	6	7
EARLY:							
Carter's Early Favourite	S	S	S	S	S	S	T
Early Epicure	T	T	S	T	T	T	T
Vick's Early	T	S	S	T	S	T	T
Warba	S	S	S	S	S	S	T
MIDSEASON:							
Bliss Triumph	S	S	S	S	F	..	..
*Cobbler	S	S	S	S	S	S	S
Early Ohio	S	S	S	S	F	..	..
LATE:							
*Netted Gem	S	S	S	..	S	F	..
*Wee MacGregor	..	..	..	..	S	..	..

S=satisfactory
F=fair
T=under trial
..=behaviour unknown
*=especially suitable for storage

Netted Gem. Netted Gem is one of the most popular varieties of potatoes grown in Alberta, especially in the irrigated sections of the south and in the western and central parts where considerable moisture is usually available. It is not suited to the drier areas nor to the extreme north where the season is short, since it requires ample moisture especially in the latter part of the growing season and is rather late in maturing.

This variety has white blossoms. The tubers are elongated, have a yellowish to brown netted-skin, shallow eyes and white flesh. They are less subject to damage by common scab and late blight than tubers of smooth-skinned varieties. They store well and usually are good in quality, especially for baking.

Wee MacGregor. This variety originated at MacGregor, Manitoba. It is a good yielder where moisture is abundant and the season is long, but it is not suited to dry areas nor northerly districts. At present it is grown commercially only in the Edmonton district. It belongs to the same group as Green Mountain and Gold Coin and hence is similar to them. It is another white-blossomed variety. The tubers are large, oblong with blunt ends and have smooth white to yellowish skins, eyes of medium depth and white flesh. They store well when mature and are good in quality.

Early Ohio. Early Ohio is a medium early variety, and one of the better sorts for the drier parts of the province where it is often grown for home use as a main crop variety. It has white flowers and pink tubers. The latter are oblong in shape and have eyes of medium depth. The cooking quality is usually good. The red color of the skin and the red streaks in the flesh, however, are disadvantages on the late crop market.

Irish Cobbler. The Cobbler group of potatoes contains several medium early varieties, which are very similar if not identical. Irish Cobbler, the best known of these, has been widely grown in western Canada and is suitable for commercial production for the early market, especially in southern Alberta. This variety has rose-purple flowers and roundish white-skinned tubers. It is one of the more productive of the white-skinned early varieties and is recognized as having good cooking quality. Deep-eyes, a tendency to roughness and excessive size and susceptibility to certain diseases such as scab and late blight are some of the disadvantages of the variety.

Bliss Triumph. This variety had a demand on the early market for many years. It has pale lavender blossoms and the foliage is quite distinctive. The tubers are quite round, the skin uniformly red and the eyes of medium depth. It is not an

especially mealy potato but the flavour is good. Susceptibility to disease and drought are two of the weaknesses of this variety.

Carter's Early Favourite. Among early varieties Carter's Early Favourite has gained wide popularity in central and northern Alberta because of its earliness, its ability to yield well and its good quality. This variety has white blossoms, smooth, oblong tubers with white skins and creamy flesh. It is susceptible to scab and to certain virus diseases of the mosaic group but seems to yield well in spite of the presence of certain of the latter diseases.

Warba. Warba has some qualities as good as or better than those of Bliss Triumph, one of its parents, and also certain of its weaknesses. It tends to mature somewhat earlier and yet to yield as well or better. It seems to be widely adapted in Alberta and is popular on the early market and as an early potato for home use. It has light-pink blossoms though these are seldom seen and the tubers are creamy white with pink around the eyes. The eyes are inclined to be deep and the tubers roundish. The flesh is white and of good quality. A serious fault is a high degree of susceptibility to scab.

Vick's Extra Early. This variety and several very similar ones known under other names such as Early Beauty of Hebron, New Queen, Bovee, and Early Burpee, combine earliness with fair yielding ability. It has white flowers and pale pinkish tubers. The latter are elongated in shape and with eyes of medium depth. They are good in quality but susceptible to scab, late blight and certain other diseases.

Early Epicure. Early Epicure has been grown so far only to a limited extent in Alberta but has shown some promise as an early sort in the irrigated district around Brooks and at a few other points where it has been grown. It has white flowers and round to kidney-shaped tubers with moderately deep eyes. When dug as an early potato the skin is white, but takes on a pink color with storage.

New Varieties. Though the varieties mentioned above have proved reasonably satisfactory in Alberta, it is not implied that they are without faults. There is room for improvement in all of them.

At the present time, after a considerable period during which little change in varieties has occurred, active breeding programmes for the improvement of the potato are going forward in several countries. In the United States, for instance, a considerable number of new varieties have been originated recently eg., Chippewa, Earlaine, Earlaine 2, Erie, Golden, Houma, Kasota, Katahdin, Menominee, Mesaba, Mohawk, Pawnee, Pontiac, Sebago, Potomac, Sequoia, and Warba. A

few of these eg., Warba and Katahdin have already been grown in Canada. Others may never find a place here, but may serve as parents in breeding varieties adapted to our conditions, since some of them possess characters which we could advantageously incorporate in our varieties eg., resistance to certain insects. The varieties illustrate recent progress in the improvement of the potato by breeding. Some of them still have serious faults though representing improvement in one or more characters. Thus the variety Golden, though superior to some varieties in vitamin A content and in cooking quality is inferior in other qualities, eg., it is late in maturity, susceptible to disease and poor in keeping quality. It also has yellow flesh which though popular in parts of Europe and South America has not found much favour on this continent.

Efforts to obtain better varieties are also being made in Canada. Characters such as greater earliness, higher yield, greater resistance to disease and insect attack, resistance to drought and frost, and better quality are being sought. In Alberta attempts are being made to secure better potato varieties through introductions and through local breeding work though there is still much to be done in this field. Columbia Russet is an example of an introduced variety which has shown some promise. This variety originated in British Columbia as a seedling of Wee MacGregor. It has flattened oblong tubers with netted skins. It has yielded well in some Alberta tests though in general not as well as Wee MacGregor. Canus, on the other hand, is a new variety originating from a U.S.D.A., seedling, tested and named by the Dominion Experimental Farm at Lacombe. It is medium early and produces high yields of smooth, creamy white uniform tubers which are roundish, oblong and slightly flattened. This potato possesses good quality but its disease reaction has not as yet been definitely determined.

IMPROVEMENT OF ALBERTA'S POTATO CROP

The production figures presented in Table I show that average yields of potatoes in Alberta are low. While it is realized that climatic factors beyond our control have played an important role in keeping down yields, there is no doubt but that the use of improved varieties and better cultural methods could effect a considerable increase in the yield of our potatoes. The same practices could be employed to bring about appreciable improvement in quality.

As already indicated there is still considerable possibility of improvement upon present varieties. The chief opportunities of the plant breeder would seem to lie in the selection of

seedlings from hybrid seed or from seed of existing varieties. Selection of tuber-propagated plants from present varieties, offers much less chance of producing distinctly new and improved sorts. It nevertheless is an important practice which can be used advantageously in the maintenance of purity and vigor of seed-stocks and in preventing deterioration through disease.

Aside from improving the potato itself, we can without doubt change our cultural practices in many cases in such ways as to step up our yields as well as the quality of our potatoes. The potato grower can and should do much for himself in this direction. Methods which may be employed are considered in the next section.

POTATO CULTURE

General Methods

In general, the practices employed in growing potatoes for different purposes are the same, though procedures naturally vary somewhat with the size of planting, the use to be made of the crop, the presence or absence of pests, the soil and climatic conditions of the district and so on. We shall consider general methods first and special methods necessary in seed production afterwards.

Selection of "Seed" and Variety

Good "seed" is essential to successful potato production. It is poor economy to use any but the best "seed". If seed is being purchased, the grower should secure certified seed. This insures that it has been derived from fields inspected for purity of variety, vigor of growth and freedom from disease by competent inspectors and that it has again been passed upon after harvest by such authorities. If the grower plans to use his own seed he will be wise to satisfy himself that he has a variety suited to his district, that it is reasonably pure, vigorous and disease-free. He should examine the growing crop from which he plans to take his "seed" with these features in mind. If after careful scrutiny of the crop it appears of doubtful value for seed he should plan to secure new seed for the next year. If it seems satisfactory he may well select a portion of this crop for seed purposes, digging out and eliminating any plants which are diseased or otherwise undesirable. The sooner this is done the better. The more careful grower may take still further precautions by maintaining a seed plot each year planted by the tuber unit method described later under "Seed Production." Whether this is done or not, further selection should be made of the harvested tubers. Only the best medium-sized tubers should be saved for seed and these should be guarded from frost and other unfavourable

conditions and carefully preserved in well-ventilated storage quarters during the winter at a temperature of about 35°F. Tubers intended for seed should not be subjected to low temperatures below the freezing point or even to chilling either before or after harvest if this can be avoided. It is also as a general rule not wise to use small unmarketable tubers for seed unless one is certain that they came from healthy plants. It is better to dig seed potatoes early rather than run the chance of exposing them to frost damage.

The variety chosen should be one suited to the district (see previous section on varieties). If intended for market, consideration should be given to the market demands and to other supplies of the same variety in the district concerned. If a carload or more can be made up in the district, the chances of sale are likely to be increased.

Soil and Soil Preparation

Potatoes are grown with considerable success on a variety of soils but better results are likely to be obtained on deep, fertile, sandy loams than on very heavy clays or on very light soils. Soils which are very alkaline, which tend to bake or which are subject to flooding or rapid drying, should be avoided.

In preparing land for potatoes several factors should be kept in mind. It is of first importance under our conditions to make the best provision possible for an adequate supply of moisture for the crop. The soil should be in a good state of fertility, that is, it should contain available plant nutrients in sufficient amounts. It should be in a good physical condition, well supplied with organic matter and friable to a good depth. Finally, it should be in a good biological condition so that the crop may escape pest danger as far as possible and make vigorous growth.

Potato growers in the irrigated districts of the province have a decided advantage in being able to control the moisture factor. This coupled with certain other associated advantages enables them to produce the highest yields and some of the best quality potatoes grown in Alberta. The cost of irrigation has of course to be balanced against the increased yield.

Irrigating only in the fall previous to the year potatoes are planted often gives fair yields, where summer water is not available. In dry years, irrigating soon after blossoming starts, with subsequent irrigations at fourteen to twenty day intervals, depending on the season and the soil, is considered good practice by authorities of the Dominion Experimental Station at Lethbridge. They are also of the opinion that irrigating before blossoming is unnecessary unless the soil is so dry as to retard growth.

The other soil requirements besides moisture can largely be provided by growing potatoes in a suitable rotation with other crops and by applying fertilizers where necessary.

Potatoes respond well to thoroughly prepared soil with a generous supply of available nutrients. These factors can be insured on an irrigated farm by beginning soil preparation the season before the potatoes are to be planted. Potatoes do very well following a partial summer-fallow after harvesting one crop of clover or alfalfa hay; also after peas and after a black summer-fallow. In all cases the land should be worked and irrigated as early as possible during the year previous to that in which potatoes are grown.

It is by no means our intention to convey the impression that successful potato production is confined to the irrigated sections of Alberta. Excellent crops are grown in non-irrigated parts, particularly in the areas receiving most rainfall. The following type of rotation is suggested for such districts.

First year—grain.
Second year—grain.
Third year—seed clover or clover and grass mixture.
Fourth year—hay and/or pasture.
Fifth year—plow under about June 20 and fallow.
Sixth year—potatoes.

The grain in this rotation may be any grain. The legume planted the third year should preferably be red clover or alsike clover though alfalfa may be used. If a legume-grass mixture is planted and this is particularly desirable if the soil is inclined to drift, either timothy or creeping red fescue are suitable grasses to use. During the fourth year, the legume or legume-grass mixture may be utilized as hay or pasture or both. Then in the fifth year the forage crop should be plowed under during the latter part of June after which the land should be fallowed the rest of the season. In this way organic matter and nitrogen fixed by the legume is incorporated in the soil and moisture allowed to accumulate during the fallow period. The land should then be in excellent condition for a crop of potatoes the sixth year. A longer rotation such as that found satisfactory at the Dominion Experimental Farm at Lacombe may be preferred and may be followed in districts having similar soil and climate with the expectation of good results, viz., fallow; wheat, seed down to a legume-grass mixture; hay; hay and fallow; potatoes; wheat; oats.

In the drier open plains country the potato is less well adapted as a main crop. It is grown here chiefly to supply home needs and consequently may well be given extra care as the acreage is small and the cost of production not a major

consideration. If possible it should be grown on well-prepared summer-fallow within the confines of a wind-break. Short rotations of summer-fallow and annual crops are probably safest in the drier areas where moisture is the chief limiting factor, eg., fallow and potatoes; or fallow, potatoes and corn; or fallow, potatoes, and peas. The last of these suggested rotations has the advantage of including a legume, which could well be planted early and plowed under in midsummer as a green manure crop. It could also be used in part or as a whole in other ways, for example, to provide food for household needs or as forage for livestock. Corn mentioned in the second rotation could also be used either for human food or for livestock feed or both. Being intertilled it would also help materially in the conservation of moisture.

The practice of growing potatoes after potatoes is not a wise one, since it tends to encourage damage from certain diseases and insects.

Fertilizers for Potatoes

Potatoes like other crops respond to fertilizers. They may respond even on some of our richest appearing soils such as our black soils, but they are likely to benefit most on our less fertile soils such as our gray wooded soils and where moisture is adequate to make the fertilizers available. It will be noted that in most of the rotations outlined above, a legume is included and plowed under the year previous to the potato crop. The legume if properly inoculated with legume bacteria will supply nitrogen fixed from the air. This is one of the cheapest and best ways to fertilize with nitrogen. At the same time the physical condition of the soil is improved by the organic matter turned under.

If well-rotted manure is available this may often be used to advantage but should ordinarily not be applied just before planting potatoes. Manure should be applied the previous year before the land is plowed for the fallow period, and may be used whether or not a legume is employed. On irrigated land at the Dominion Experimental Farm at Lethbridge, the application of barnyard manure has increased yields more frequently than commercial fertilizer. Manure is of value not only in improving the fertility of the soil but also its physical condition. However, being low in phosphorus it may be advisable when using it on certain soils to supplement it with a phosphate fertilizer.

Commercial fertilizers have not been widely used for potatoes in Alberta. The Provincial Advisory Fertilizer Committee for Alberta has recently concluded that "there is not sufficient experimental evidence at the present time to warrant recommendations regarding the use of fertilizers on potatoes.

In the work which has been done, however, some promising results have been obtained. Increases varying from a few bushels per acre to upwards of fifty bushels per acre have followed the application of various fertilizers. In some experiments ammonium phosphate has given good results. This suggests that the potato grower might use fertilizer on at least a limited portion of his crop in order to determine his own fertilizer requirements."

The results of the following tests conducted in 1945 bear out the above conclusions.

Effect of Applying Ammonium Phosphate Fertilizer to Alberta Soils on the Yield of Potatoes in 1945

Location	Soil Type	Fertilizer	Yield bus. per acre	Increase from Fertilizer bu. per ac.	Increase from Fertilizer percent
Fallis	Gray	none	234		
Fallis	Gray	ammonium phosphate 16-20*	297	63	27
Edmonton	Black	none	481		
Edmonton	Black	ammonium phosphate 16-20*	543	62	13

* applied at the rate of 200 lbs. per acre.

It will be noted that the yield increase in per cent from applying ammonium phosphate 16-20 was greater on the gray soil than on the black. This is readily explained by the differences in fertility of the two soils, the black soil being naturally much more fertile than the gray. If black soil shows any deficiency it is most likely to be a deficiency in phosphorus, whereas gray soil is likely to be deficient in nitrogen and sulphur and sometimes in phosphorus as well. Ammonium phosphate 16-20 contains all of these elements. Hence, most response from it would be expected on the gray soil. The response of potatoes to fertilizers on the brown soils has been inclined to be erratic but phosphate fertilizers seem to be needed on some. On the Dominion Experimental Farm at Lethbridge, for instance, applications of up to 150 lbs. per acre of ammonium phosphate may be advisable. It has also been noted at the same station that phosphorus is especially likely to be lacking in a field recently broken after a crop of alfalfa.

Commercial fertilizers should be applied at the time of planting in such a way that they do not come in contact with the seed pieces. They should be deposited at least two inches from the seed pieces. A fertilizer attachment on the planter may be used for large scale work. For small plantings the fertilizer may be distributed in the bottom of the furrow and covered with an inch or so of soil before planting.

Cultivation

Potatoes require a moderately deep uniform seed bed which may be prepared by plowing or tilling to a depth of at least six inches. In the drier areas it is well not to disturb the land

much before planting because of the danger of drying out the soil, but in moist areas harrowing or shallow surface cultivation to keep down weed growth is advisable. It is best to kill as many weeds as possible before planting or before the potatoes become well established. Inter-row cultivation including light hilling may be practised thereafter in order to keep down weed growth but this should be shallow in order to avoid disturbance of the roots. Deep hilling may result in more harm than good especially in dry seasons. However, moderate hilling is helpful during the latter part of the season in order to prevent sunburning and freezing of the tubers before harvest.

Preparation of the Seed

Tubers used for seed should be sound, viable, free from disease, and ready to sprout when planted. If they are treated for disease prevention (see later section under "Diseases and Their Control"), this is usually done before cutting. They should then be cut into blocky sets averaging from 1½ to 2½ ounces in weight or left whole. Each set should have at least one eye and preferably more. Any tubers showing internal discoloration should be discarded and after cutting such a tuber the cutting knife should be sterilized. Boiling water or a 1:9 formaldehyde solution may be used for this purpose. Growers having large acreages may employ a cutting machine to advantage. Cut seed should be planted soon after cutting unless subjected to suberization (see later section "Care of the Seed After Treatment" under "Diseases and Their Control"). They should be kept shaded from the hot sun until planted.

Planting the Crop

Potatoes are usually planted in Alberta during the month of May after the soil is dry enough to work and warm enough to induce germination. Early planting around May 1 may be practised for early potatoes, but later planting around the middle of May is usually safer for the main crop. Very early planting exposes the young plants to damage from spring frosts to which they are very susceptible. On the other hand very late planting is even more objectionable because of the likelihood of the soil being too dry at planting time, and too warm when the tubers are forming and because of the danger of damage from fall frosts. The time of planting varies somewhat in different parts of the province, but in general better yields are likely to be obtained from early rather than from late planting.

Methods of planting vary with the size of the planting and the importance of the crop to the grower. A mechanical planter of modern design with fertilizer attachment will be

Planting potatoes with a two-row planter in the spring of 1946—farm of E. Lewis, Winterburn, Alberta. Photo by J. W. Marritt.

needed by the commercial grower who plants a considerable acreage. The grower of smaller acreages can fit a gang plow with a hopper and lead to the bottom of the furrow of the first plow, to serve as a planter. Hand planting may be employed for still smaller plantings using a walking plow to open and cover the furrows or a spade or hoe for garden plots.

The depth of planting may be varied somewhat with time of planting and the condition and nature of the soil, but an average depth of 3 to 5 inches will usually be found best. Shallow planting is more necessary for early planted potatoes and for potatoes planted in heavy soil. Deeper planting may be desirable on the lighter soils and for later seedings. Deep planting in cold wet soil is likely to encourage rotting of the sets.

Potatoes are usually planted in rows from 30" to 36" apart with the sets placed 12" to 16" apart in the row. Spacing should be adjusted according to the probable moisture supplies, the drier the soil the wider the spacing. With rows 36" apart and sets 16" apart in the row the amount of seed required will be approximately 10, 16 and 21 bushels per acre for 1, 1½, and 2 oz. sets respectively. Tuber-unit planting, especially useful in seed production, is described on page 21 under "production procedures."

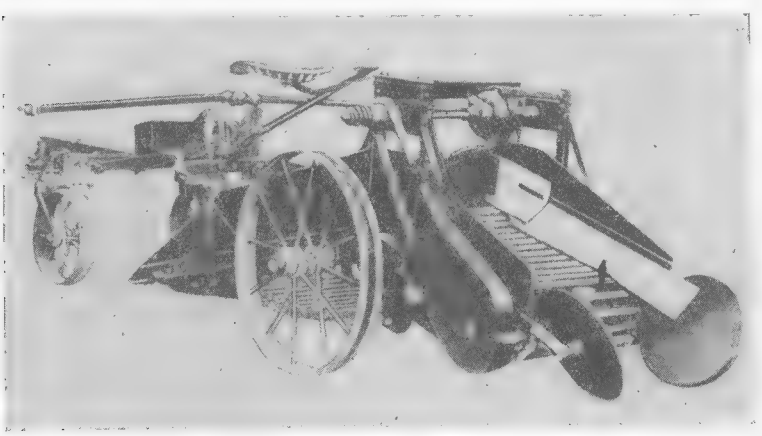
Care of the Growing Crop

The growing crop should be cultivated sufficiently to keep down weed growth. In addition it should be watched for other forms of infestation, particularly for the appearance of insect pests and diseases. If pests such as the potato beetle or the late blight fungus appear it may be advisable to spray or dust the foliage (see following sections on insect and disease control). Also if scattered off-type plants appear showing symptoms of virus diseases or characteristics of other varieties, these should be removed completely as soon as they are detected, at least from any stocks intended for seed.

Harvesting

Digging should be done before there is danger of severe frosts, sufficient to freeze the soil surface. Early potatoes are likely to be ready for harvesting before this danger arrives, but under our conditions it is often necessary to delay the harvesting of late main crop varieties until fall frosts are upon us. Also if at all possible harvesting should be done during drying weather. In harvesting potatoes for the early market it is especially important to avoid exposing them to the sun and to high temperature after digging. They should not be subjected to temperatures above 70°F. for longer than twenty minutes.

As in planting the job may be done mechanically or by hand depending on the size and importance of the crop. Mechanical diggers of several types remove potatoes satisfactorily from the soil and speed up harvesting greatly. Some cause more injury to the tubers than others and this should be taken into consideration by the purchaser. The grower of an extensive



Potato digger designed to avoid bruising of the tubers. After A. G. Tolaas.

acreage should own a good digger or have the use of one. Smaller plantings may be handled with a walking plow and harrow or with an ordinary garden fork.

After potatoes are removed from the soil they should be allowed to dry thoroughly before bagging or storing. This will materially reduce the danger of rot occurring later.

Avoidance of bruising is important, not only at digging time but also in handling afterwards. Injuries reduce saleability and encourage decay. Freshly dug and immature potatoes are particularly subject to skinning and other forms of mechanical injury.

Storing

There is little point in growing potatoes and then wasting them by allowing them to rot in storage. Yet many thousands of bushels are lost annually by careless storage.

Only sound potatoes should be stored. They should be dry and as free from soil as possible. They should be handled when the temperature is considerably above the freezing point and in such a way that they will incur the least possible mechanical injury, and be exposed as little as possible to contamination by disease-producing agencies. Sacks or other containers used should be clean.

Storage quarters should be prepared ahead of time. They should be thoroughly cleaned and disinfested (see disease section) before the new crop is brought in. Essentials in the storage quarters are good ventilation and provision for keeping the temperature cool for most of the storage period and for

Durable small storage cellar at Edmonton, Alberta, having concrete foundation, frame roof, and ventilation inlets and outlets through the ends.

excluding light and excessive humidity or dryness. Ventilation is important and should be provided not only by one or more adjustable vents to the outside but also by using slatted containers raised off the floor to permit better circulation of the air.

It is not necessary to place potatoes immediately in cold storage, in fact it is better to leave them at room temperature for a week or two to permit their skins to mature and injuries to heal. Temperature during the main storage period should be kept around 38 to 42°F. for table-stock. Light can usually be excluded sufficiently without difficulty and humidity will usually be adequately controlled if the ventilating system is satisfactory.

Potatoes in storage should be examined at intervals for signs of decay. This may or may not be detected by the odor. If soft rot is detected it will be necessary to pick over the potatoes and discard the decayed ones. Careful control of the factors mentioned above should, however, to a large extent avoid the necessity of this.

Left: Large storage cellar (36ft. by 50ft.) at Brooks, Alberta, with tile and timber construction and shaving insulation. This cellar has an attic suitable for seed cleaning, etc., and a 12ft. driveway. It holds about 10 carloads of potatoes with driveway filled. Photo by P. D. Hargrave.

Right: Large storage cellar (30ft. by 80ft. at Duchess, Alberta, constructed of wooden poles, covered with willows, straw and soil. An alleyway easily permits the passage of trucks through the centre. This cellar has ventilating shafts through the roof. It will store about 20 carloads of potatoes. Photo by P. D. Hargrave.

Marketing

If Alberta potato growers who produce potatoes for sale are to secure and hold markets they must build a reputation for quality of their product. Quality in potatoes whether they be for food, for seed or for other uses is just as important as is quality in other agricultural products such as wheat, barley, bacon or beef. Potatoes should be carefully graded and prepared in clean attractive containers before they are offered for

sale. An assured supply of such a product in a district will also do much to create a demand both inside and outside the province. Alberta can produce high quality table-stock and seed potatoes, and districts well suited to the production of either or both may find it advantageous to specialize in potato production at least as one of their farm enterprises. To this end an active, well-organized local potato association can do much to foster the industry.

According to the Fruit, Vegetables, and Honey Act, and Regulations of Canada, no person shall ship, transport or sell potatoes which are below the minimum grade (Canada No. 2) except to a person engaged in the operation of an assembling, processing or manufacturing plant.

The grades recognized at present are as follows:

1. Canada Fancy
2. Canada No. 1
3. Canada No. 1 Large
4. Canada No. 1 Small
5. Canada No. 2

"Canada No. 2 Potatoes" must be of similar varietal characteristics, reasonably mature and firm, free from freezing injury or soft rot and may contain not more than 4% of other defects. Not more than 2% of the potatoes may be less than 1¾" in diameter and 75% of the potatoes must be 2" or larger in diameter.

Producers should note that "Canada No. 2" is the lowest grade of potatoes that may be legally marketed and that the most desirable markets can be attracted only by the best grades.

Additional regulations governing the sale of commercial table-stock potatoes in Alberta given under the Vegetable Sales Act (Alberta) R.S.A., 1942, include the following provisions:—

(*a*) Every person who packs, ships, sells or offers for sale any potatoes in a closed package shall mark the package by attaching a suitable tag showing his name and address, the proper grade as defined in the Regulations, and the net weight of the contents when packed.

(*b*) Notice of intention to ship vegetables in carload quantities indicating time and point of loading and the consignee shall be given by the shipper to the nearest vegetable inspection office in adequate time to permit inspection. Inspection shall then be at the discretion of the Department.

(*c*) Any person requiring produce to be inspected shall give adequate notice to the Vegetable Inspector, Dominion

Department of Agriculture at Edmonton, Calgary or Lethbridge.*

(*d*) When potatoes are packed in cotton, jute, mesh or paper bags, the standard for weights shall be: — 15 lbs., 25 lbs., 50 lbs., 75 lbs., and 100 lbs.

(*e*) The grade and package measure of weight of potatoes shall be specified in all advertising where prices are stated.

SPECIAL METHODS IN "SEED" PRODUCTION

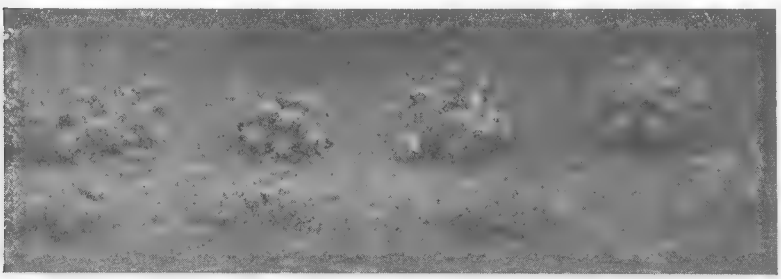
The successful production of "seed" potatoes requires special methods and involves extra care. Hence, the growing of seed for sale should not be undertaken by anyone who is not prepared to give the enterprise the attention it needs.

Kinds of Superior Seed

Four kinds of superior seed potatoes are produced in Alberta. These are: 1) Certified 2) Foundation A 3) Foundation and 4) Alberta Indexed Foundation. Each of these classes of seed must pass inspection both in the field and in the bin by competent government inspectors and measure up to certain standards of perfection before they can be offered for sale under these grades. The first three grades are produced under the supervision of Officers of the Plant Protection Division, Dominion Department of Agriculture. They must pass required standards of freedom from disease, purity of variety, vigor, etc., both in the field and in the bin before they will be accepted for certification. The standards for the different grades increase in strictness from Certified up to Foundation. Alberta growers desiring to obtain information concerning these regulations, to make application for inspection or to ascertain sources of certified seed should get in touch with the local inspector Mr. J. W. Marritt, Blowey-Henry Building, Edmonton. Detailed methods of producing these three grades of seed potatoes are also obtainable from the same source.

The qualifications for Alberta Indexed Foundation Seed Stock are more exacting than those for Foundation seed. The most important additional requirement is that they be produced from seed grown in a special plot planted according to the tuber unit method and that the seed for this must come from indexed tubers, that is tubers which have been individually tested for disease in the greenhouse during the winter, by growing a plant from an eye extracted from each. Only those tubers which produce disease-free plants in such a test are saved for planting the seed plot. This class of seed is

* Make application for inspection of table-stock commercial potatoes to Dominion Fruit and Vegetable Office at your nearest point, or offices located at Edmonton, Calgary or Lethbridge.



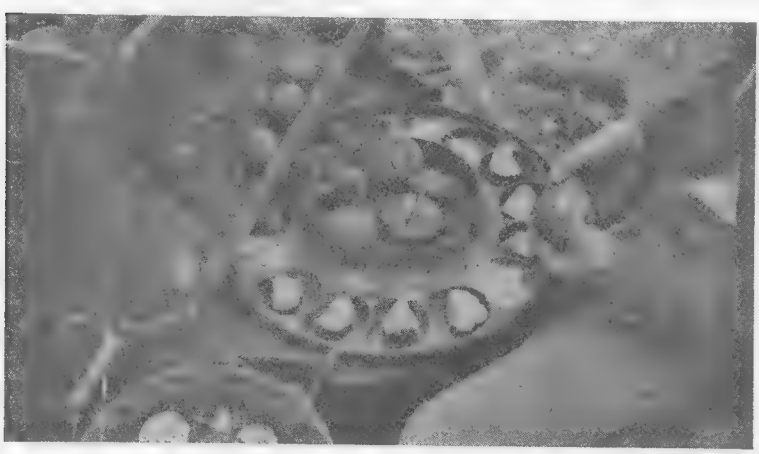
Potatoes planted in tuber units. The upper four plants constitute a good tuber unit while the lower four make up a poor (diseased) unit. Tuber units showing one or more off-type plants should be removed in their entirety as soon as they are detected.

produced in only very limited quantities by seed-growers under the co-operative supervision of the Alberta Department of Agriculture, the University of Alberta, and the Dominion Plant Protection Service. Information concerning methods of producing it may be obtained from the Field Crops Branch, Provincial Department of Agriculture, Edmonton.

One of the principle requirements of the above-mentioned classes of seed potatoes is that they be free or nearly so from disease, and particularly from virus disease. This is most important because disease is often a major limiting factor in potato production and the use of disease-free seed is one of the best ways of preventing losses from disease.

Production Procedures

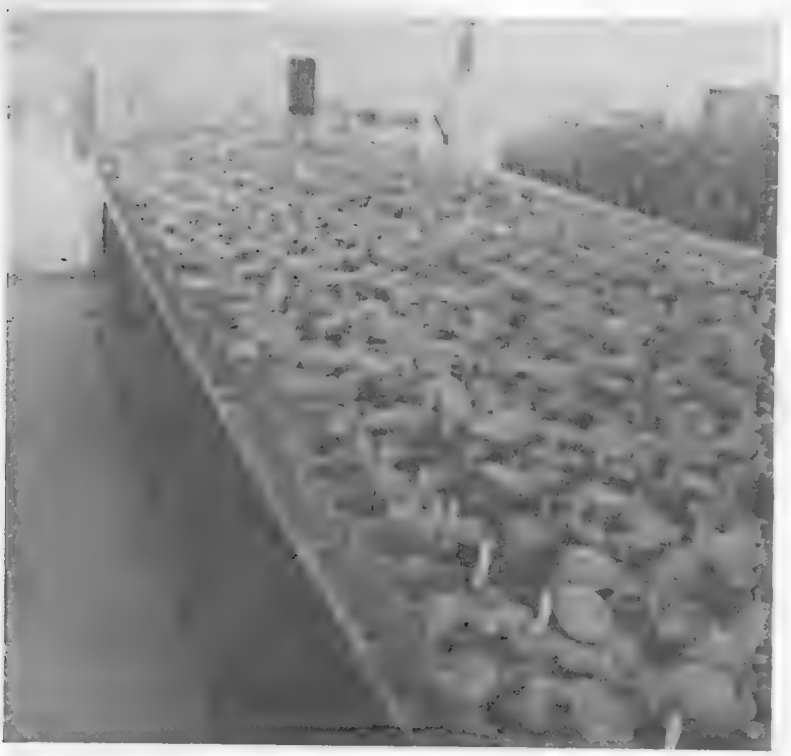
Certain procedures are of special importance in the production of disease-free seed. One of these is the maintenance of



Device making possible tuber-unit planting by machine. The planter shown in Fig. 7 is so equipped. After Wyoming Bulletin 270.

an isolated seed plot at a distance from other potatoes to avoid the spread of viruses by means of insects. Another is the planting of a seed plot by the tuber-unit method, so that effective roguing (eradication of diseased plants) may be accomplished. By this system, each tuber for planting the seed plot is cut into four and these sets are then planted one after the other in the row to form a tuber unit. Then one hill is left vacant and another tuber unit is planted and so on until the seed plot is completed. When the plants come up they are examined at intervals for disease. Whenever a diseased plant is detected all the plants of the unit in which it appears are dug up and discarded. This makes possible much more effective eradication than can be effected when ordinary methods of planting are practised.

Seed growing demands special care not only in the ways indicated above but in fact at all stages, from the selection of the seed for planting to the marketing of the final product.



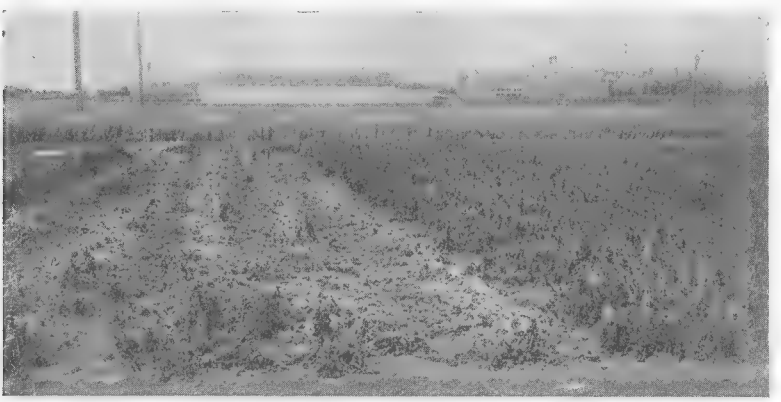
Indexing potatoes in the greenhouse at the University of Alberta, an important step in the production of Alberta Indexed Foundation Seed Stock. Each plant is from an eye from a single tuber. Only those tubers yielding disease-free plants are saved for planting seed plots.

One must start with good seed, since there isn't much use trying to produce good seed from poor seed. Since 1944 the Dominion Government has required that all potatoes accepted for certification must be grown from Foundation or Foundation A potatoes and the Government of Alberta requires that seed for Indexed Foundation Seed Stock potatoes be from a tuber-unit seed plot arising from indexed tubers. Pest control in seed potatoes must be given special attention. This applies to weeds, insects and disease-producing agencies. Roguing out of diseased off-type plants must be done carefully and repeatedly during the season. Harvesting should be done early before danger of frost, and so that late spread of viruses will be reduced. Careful selection and grading of the tubers should be done after harvest. The seed tubers should then be stored carefully, preferably at about 35°F. for the main storage period, and so that no danger of mixing with other potatoes may arise. When ready for sale they should be regraded, placed in clean sacks, and if shipped they should be handled in such a way that they will not be exposed to frost or other damage in transit.

One can obtain and use just ordinary potatoes for seed but this is "penny wise and pound foolish". Using good seed is the best insurance one can take out so far as the potato crop is concerned.

HAZARDS IN POTATO PRODUCTION

The occurrence of pests such as disease-producing agents, insects, and weeds, constitute hazards to potato production wherever the crop is grown. In addition, unfavourable



Frost damage to potato plants, resulting from seven degrees of frost which occurred at Edmonton on August 24, 1934. The early variety Warba (left) was more severely damaged than the late variety Katahdin (right). After O. S. Aamodt.

environment factors, such as frost, drought and hail create additional problems for the potato grower.

The relative importance of the different pests of the potato varies in different places and at different times. We should seek to reduce damage from each to the lowest possible point. However, while dealing with one we cannot safely disregard the others. We must endeavour to deal effectively with the combination if we are to safeguard the potato crop.

Potato Diseases and Their Control

The potato plant is notorious for its susceptibility to disease. Undoubtedly, disease is a major limiting factor, in the production of this crop. One of the main reasons for this is that certain agents of disease persist more successfully from one season to the next in a vegetatively propagated plant like the potato than in plants propagated from seed.

There are so many diseases of the potato that it would take a separate bulletin to deal with them in detail, so we shall attempt here only to discuss them in groups.

Potato diseases which we shall consider here may be classified according to cause into four main groups (1) virus diseases (2) bacterial diseases (3) fungus diseases and (4) miscellaneous abnormalities.

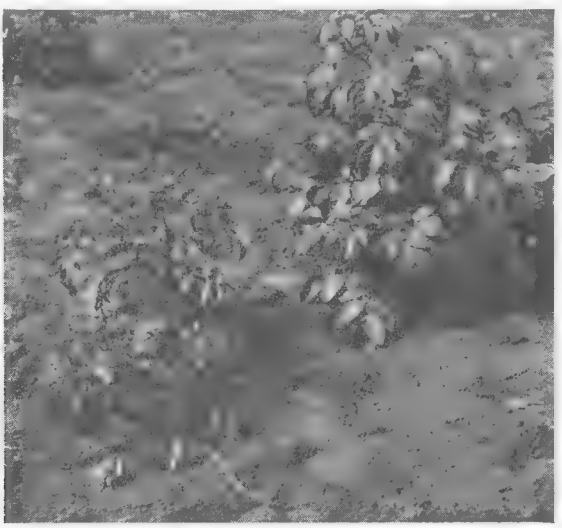
Virus Diseases

These diseases are present everywhere in potatoes and are often considered to be largely responsible for the degeneration or "running out" of potato stocks. They are caused by transmissible infectious principles called viruses which are so small that they are invisible with the ordinary microscope. They occur in the juices of diseased plants both in the tops and in the underground parts including the tubers. Most of the potato viruses are transmitted from one crop to the next, if diseased tubers are used for seed. Consequently, most virus diseases of the potato become progressively worse from season to season if the same seed-stock is used. In fact, if certain viruses are present in a stock of seed potatoes it may become practically worthless in two or three years. This is one of the main reasons why disease-free seed is so important in potato growing. Unfortunately, in many cases, the only means of detecting the presence of viruses in tubers is to grow plants from them.

Another important feature of plant viruses is that many of them are spread in the field from plant to plant by means of insects (aphids or green flies are among the most common carriers) so that a few scattered diseased plants may serve as sources of infection for the rest of the plants in the field. The

tubers of the latter in turn become infected and may pass the virus on to the next crop. Thus viruses can multiply very rapidly in a stock. Some of them singly and others in combinations reduce yields greatly. Virus diseases are recognized largely by abnormalities of the foliage, less often by tuber symptoms.

Leaf Roll is one of the most common and destructive of these diseases in Alberta, especially in and around cities. The chief symptom is an upward rolling of the leaves. The affected plants are usually stunted and the yield of tubers is often much reduced. The tubers of plants infected for the first time may show an internal net necrosis of the flesh.

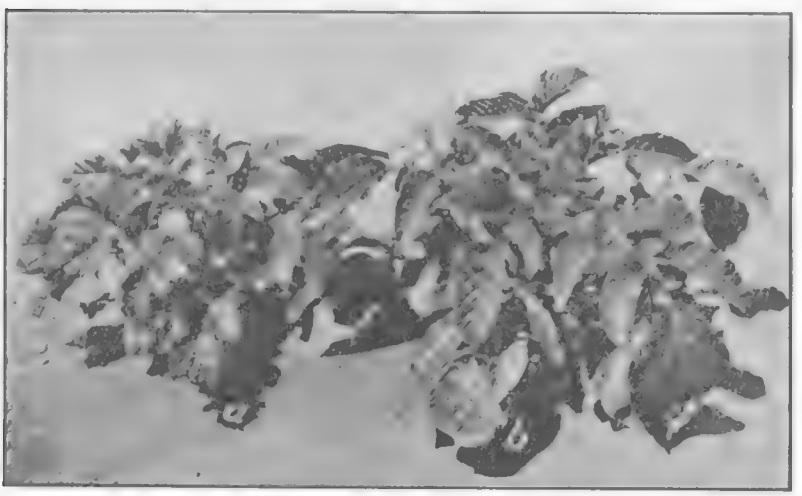


Leaf Roll, a common and destructive virus disease in Alberta: left, diseased plant; right, healthy plant.

Mosaic Diseases representing another type of virus disease, are also encountered in Alberta crops. Plants affected with these diseases show mottling of the leaves, very faint in some cases, quite pronounced in others. Crinkling, stunting and other deformities may or may not accompany the mottling.

Other Virus Diseases. Less common virus diseases include Spindle Tuber and Witches' Broom. The former is characterized by abnormally slender tubers and the latter by an excessive development of shoots. Several other diseases suspected of belonging to the virus group also occur here.

Mild Mosaic in a Green Mountain potato leaf. After Schultz, Bonde and Raleigh.



Rugose Mosaic of Burbank potatoes: left, diseased plant; right, healthy plant. After McKay and Dykstra.

Bacterial Diseases

The bacterial diseases of the potato are caused by tiny microorganisms which are visible with the aid of the microscope. These parasitic organisms also are carried from one crop to the next in diseased tubers. One of them is a very common soil inhabitant. Three diseases of this type occur in Alberta, namely Ring Rot, Blackleg and Common Scab.

Ring Rot has made its appearance here only recently. So far it has been found chiefly in the southern part of the province. The causal bacteria are highly infectious and destructive and consequently every effort is being made to prevent their spread. This disease does not make itself evident as a rule until late in the season when the leaves of affected plants turn yellowish, wilt and die and the tubers rot in a ring beginning about a quarter of an inch inside the skin. The rotted tissues take on a brown cheesy appearance and the decay

Potato tubers affected with Ring Rot: top, typical cracking of surface layers which often occurs in advanced stages of the disease; bottom, progressive stages of internal decay starting from the vascular ring.

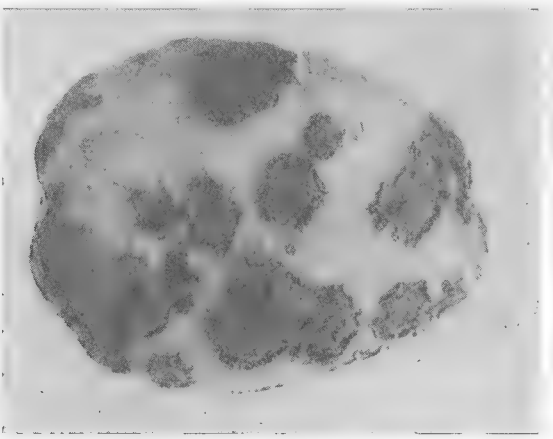
gradually extends, throughout the tuber, the skin often cracking over the badly rotted parts.

Blackleg has been present in Alberta for many years and is fairly common especially in the irrigated and moister sections. In this disease a soft rot develops at the base of the stems causing the tops to become sickly. The rot at first has a greenish water-soaked appearance but later turns quite black. The disease becomes evident about midsummer or earlier and

Soft rot of the base of the stem, a typical symptom of Blackleg of the potato. After McKay.

affected plants are easily pulled up. The tubers often develop a soft rot beginning usually at the stem-ends. The tubers may rot in the field and also in storage if conditions are favourable for the disease.

Common Scab is a disease of the tubers primarily and occurs very widely in Alberta. Scabby areas on the surface of the tubers are characteristic of this disease, which is familiar to most potato growers. The causal organism may be contracted from the soil as well as from contaminated tubers. This disease is favoured by alkaline soils and unfortunately most of our soils seem to encourage its development.



Potato tuber affected with Common Scab. After F. M. Blodgett and F. B. Howe.

Fungus Diseases

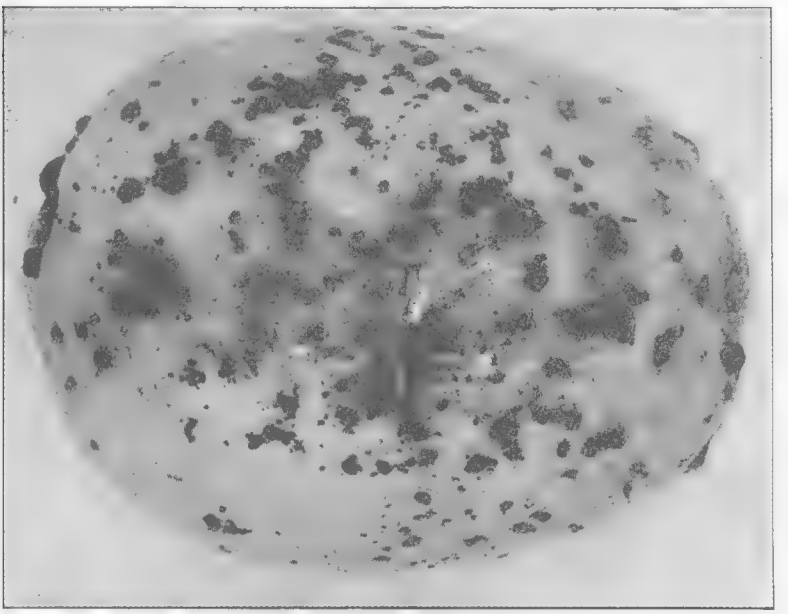
Diseases in this group are caused by parasitic moulds or fungi. Those which cause disease in potatoes are transmitted from one crop to the next on or in diseased tubers used for seed, as are viruses and bacteria. Some are air-borne as well and some are soil-borne. Several of these fungi occur in Alberta and each causes a distinct disease.

Rhizoctonia or Black Scurf is a very common fungus disease of the potato, and is very prevalent in Alberta. It is characterized by brown lesions which form on the bases of the stems above the sets and often girdle them. Sprouts and underground stems may develop similar lesions. As a result of such injury the yield of tubers is reduced and numerous small tubers may form instead of large ones. The tops may show abnormalities by rolling of the upper leaves and occasionally by the formation of aerial tubers in the axils of the leaves. As the tubers mature they often develop black specks on the skin,

Potato plant showing Rhizoctonia cankers on the stem. After McKay.

resembling particles of soil, but which do not readily wash off. These are resting bodies or sclerotia of the causal fungus, and serve to transmit the fungus to the next crop if infested tubers are used for seed. The causal fungus also occurs commonly in the soil.

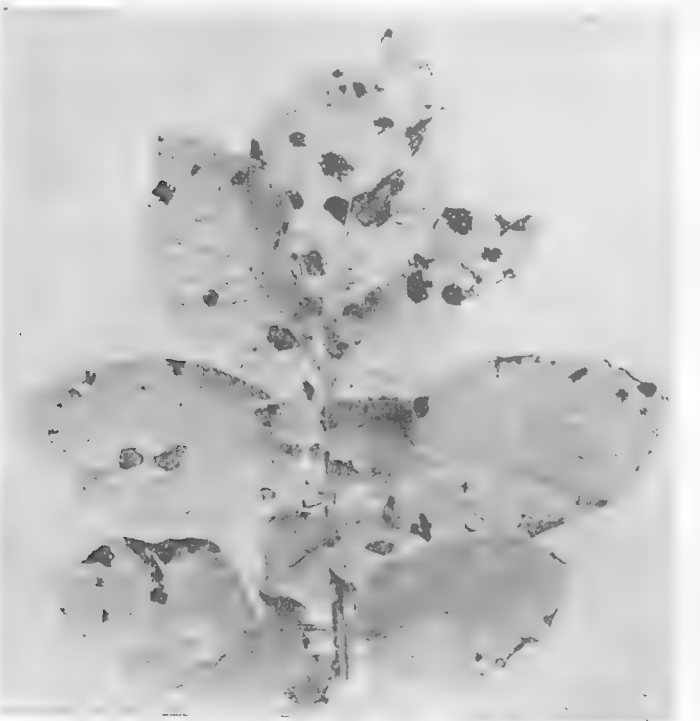
Early Blight is another common fungus disease of the potato in Alberta. It affects the leaves chiefly, on which brown spots showing faint concentric rings are formed. Sometimes these become so numerous as to seriously reduce the functional leaf surface and the yield of tubers is consequently lowered.



Potato tuber affected with Rhizoctonia or Black Scurf. After Morse and Shapovalov.

Often, however, the spots are few and the damage slight. The causal fungus is air-borne chiefly but as well is tuber-borne.

Late Blight is a very destructive disease and one that has caused immense losses in some potato-growing regions. It fortunately has not occurred extensively in Alberta, probably due to the dryness of our climate. However, it has occurred recently in the Edmonton district in moist seasons and has done considerable damage in certain fields and gardens. Both tops and tubers develop symptoms. Water-soaked areas which later turn brown develop on the leaves and stems. If conditions are very favourable the tops may be completely blighted and reduced to an ill-smelling mass in a few days. The tubers also are usually invaded and often rot in the field or later in storage. Brownish to purplish blotches appear on portions of the tubers and underneath the skin the flesh develops a firm rusty rot. This is often followed by softer rots produced by other organisms. The causal fungus multiplies quickly in favourable weather and spreads rapidly through the air. Thus it is able to cause much destruction in a short time. It lives over winter in diseased tubers, which consequently should be destroyed before the next crop is planted. They should not be used for seed nor left exposed in dump piles.

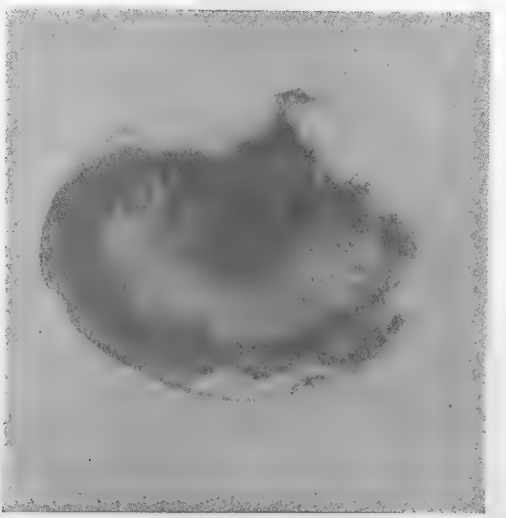


Early Blight. After Cornell Extension Bul. 135.

Wilt Diseases. There are at least two wilt diseases of the potato caused by fungi, which occur in Alberta, namely *Fusarium Wilt* and *Verticillium Wilt.* These are similar in behaviour in that they invade the vascular or conducting tissues of affected plants, and cause them to lose color, roll their leaves, wilt and often die prematurely. The tubers are also invaded and usually show a brown discoloration of the vascular ring beginning at the stem end. The causal fungi live over from one season to the next in diseased tubers and possibly in the soil as well.

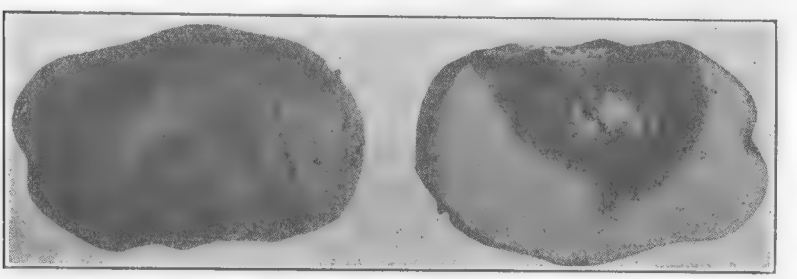
Tuber Rots. A number of fungi attack potato tubers and cause trouble particularly in storage. Some of these rots originate in the field and continue to develop and cause trouble in storage. The fungi causing these rots usually enter the tubers through wounds or through injuries caused by frost or by more active parasites. They are encouraged not only by unsoundness in the tubers themselves but by other factors as well, such as high moisture content of the soil, storage of tubers without proper drying, unsanitary conditions, and improper re-

Late Blight, showing leaf and tuber symptoms. After Ducomet et al.



Tuber rot caused by Pythium ultimum. After Dykstra.

gulation of ventilation, temperature and humidity in storage. Tuber rots as we have already noted may be caused by bacteria and fungi which attack other parts of the plant as well, such as the Blackleg bacterium and the Late Blight fungus. The tuber rots we have reference to here confine their attacks to the tubers, so in a sense are less aggressive parasites. Such fungi as species of *Pythium* and *Fusarium* are among the more common causes of such tuber rots in Alberta. They are widely distributed in the soil, on dirty sacks, in storage cellars and in other situations where potatoes are likely to come in contact with them. If favourable conditions for them prevail when this happens, they may enter the tubers and cause destructive rots.

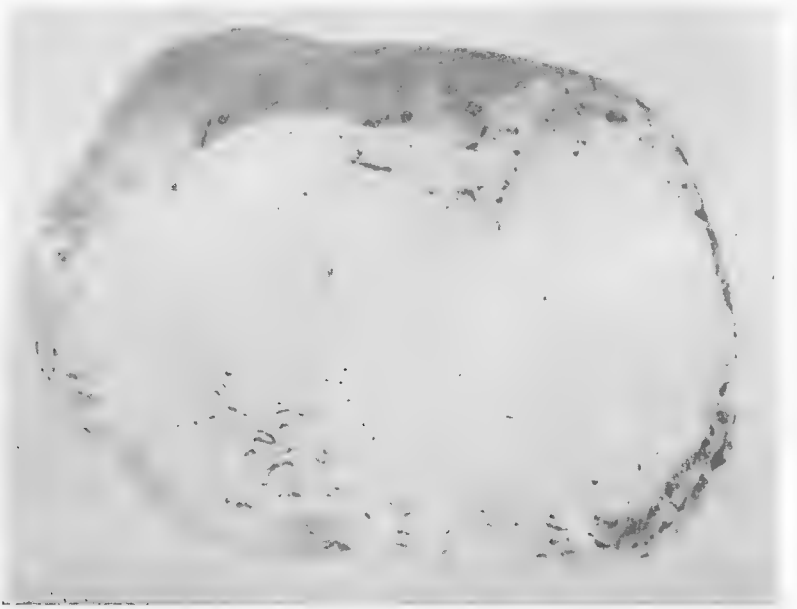


Tuber rot caused by Fusarium sp. After G. B. Sanford.

Miscellaneous Abnormalities

The potato is subject to many other forms of disease damage some of which is caused by parasites and some by non-parasitic agencies such as unfavourable environmental factors. The following are but a few that affect the tubers particularly.

Net Necrosis. This abnormality takes the form of a brown netting of the flesh of the tubers. It is quite commonly encountered and is a source of annoyance both to the grower and to the consumer. Several different agencies may cause this type of abnormality. It is known that it may result from the presence of a virus, e.g., the leaf roll virus. It also may



Net Necrosis of the potato tuber, an occasional symptom of Leaf Roll. After Dykstra, courtesy of the Maine Agricultural Experiment Station.

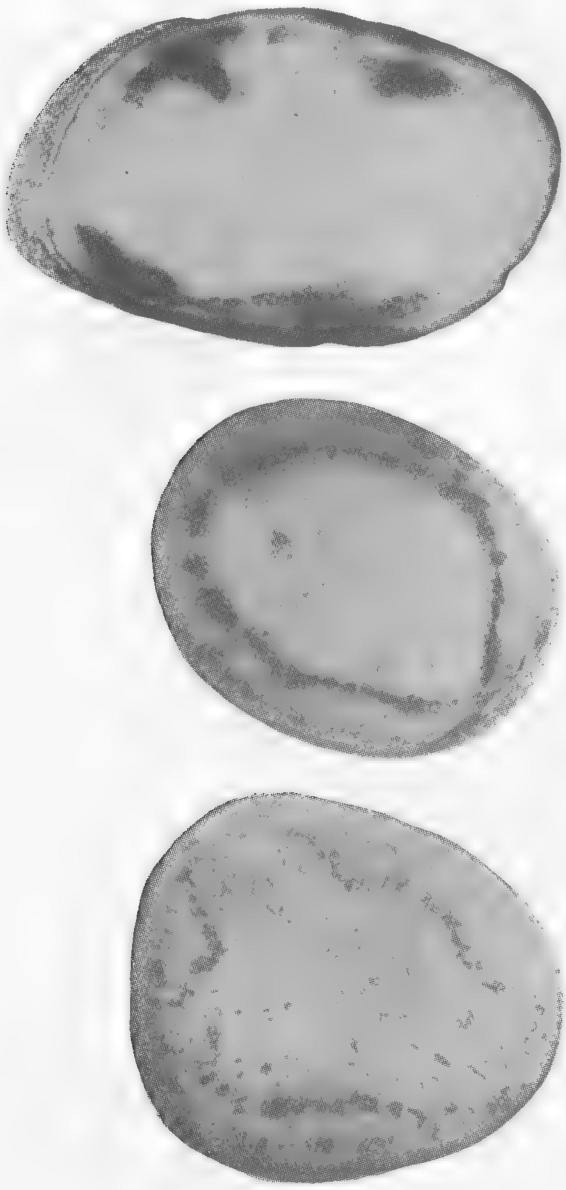
develop following the feeding of insects, e.g., Psyllids, and it may occur as a result of exposure to a light frost. Moreover, it may develop more readily in some varieties than in others. Obviously to prevent it we must destroy or avoid agencies which are known to cause it.

Ring Necrosis is a well known symptom of certain diseases caused by specific parasites. Thus in *Fusarium Wilt* and *Verticillium Wilt* a brown discoloration is commonly found in the vascular ring at the stem-end of the tuber and for some distance around the tuber about a quarter of an inch in from

the skin. It should not be concluded, however, that such a brown ring in the tuber is sufficient evidence that it is affected with one of the wilt diseases. Ring necrosis often occurs in the absence of parasites. It may be induced by low temperatures and possibly by drought or other factors. It has been quite prevalent in some years in Alberta and rare in others suggesting that seasonal factors such as moisture supply are concerned in its production. If we use disease-free seed, provide the best growing conditions possible and protect the tubers during and after harvest from injury we will be taking such precautions as we can against the occurrence of ring necrosis.

Frost Injury. Alberta potatoes are often exposed to low temperature before or after they are harvested. We tend to take this for granted and perhaps do not guard against it sufficiently. More serious consequences may result from such exposures than some people realize. Even chilling is reported to reduce the seed value of potato tubers. Slight frost resulting in ice formation in the tissues may cause various types of internal necrosis, such as net necrosis and ring necrosis already mentioned and as well a blotchy type of discoloration. There may be no external evidence of such injury except occasionally when blotches near the surface show through the skin, yet affected tubers are considerably reduced in value both for table use and for seed. More severe frost is likely to freeze solidly exposed portions of tubers or sometimes whole tubers. When thawed in warm air such tissues become soft and watery and dark in color, while if thawed in cold air they take on a mealy to leathery whitish appearance as they dry out. Such tissues are very apt to be invaded by bacteria and fungi which set up rots that often do more damage than the frost. Early harvesting, proper covering and careful storage are obvious methods of preventing frost injury to potato tubers. If the temperatures are low, around the freezing point, potatoes should not be handled because handling may induce ice-formation in the tissues which would probably not occur if the potatoes were untouched while at such critical temperatures.

Blackheart and Hollow Heart. These two abnormalities of the central part of potato tubers are often confused. They are, however, quite different and due to different causes. Blackheart is characterized in its late stages by a black discoloration of the centre of the tuber. Blackheart results from poor aeration. It will occur most readily if tubers are poorly ventilated and held at high temperatures. It can readily be avoided by avoiding deep piling and by otherwise providing good ventilation and by keeping the temperature around 38° to 42°F. Hollow Heart on the other hand refers to a type of cavity



Types of internal frost necrosis of potato tubers: left, net necrosis; centre, ring necrosis; right, blotch necrosis. After Wisconsin Research Bul. 46).

formation in the centre of the tubers. It is usually found in large tubers and seems to result from rapid and excessive growth. Some varieties, e.g., Rural Russet, seem more susceptible than others. Planting potatoes closer together is one means of avoiding this abnormality.

Knobbiness. Knobby tubers resulting from second growth occur quite commonly in Alberta, and represent considerable loss to the producer. Uneven distribution of moisture appears to be largely responsible for it. Wet weather following a dry period in midsummer is likely to encourage it. Regulation of the water supply where possible, the incorporation of organic matter into the soil and regular spacing are measures which should reduce second growth.

Methods of Control

The control of potato diseases, in fact of all plant diseases is based largely on preventive measures. It may at times be necessary to concentrate on the control of a single disease but the average grower must concern himself with disease control in general. Consequently, we shall deal here with the control of potato disease in general terms with occasional reference to specific diseases as it seems necessary.

Use of Selected Seed

The use of good seed selected for freedom from disease will not alone guarantee a disease-free crop but it is the best single type of insurance that one can at present take out against virus diseases. It is also of great value in preventing the occurrence of many infectious diseases caused by other agencies, e.g., Ring Rot.

The wise potato grower will always use the best seed obtainable. If he already has superior seed he should endeavour to maintain it that way by the procedures already outlined. If it is necessary to obtain new seed, he should secure some form of certified seed which has been grown by a competent seed grower and which has been inspected for freedom from disease.

Treatment of Seed

Treatment of potato tubers with certain chemicals will kill pathogenic organisms which may be present on their surfaces. It will not destroy internally-borne ones nor will it prevent the new tubers forming on a plant being attacked by soil-borne pathogens. Some chemicals, however, will protect the sets from contamination and from rotting after treatment. Seed treatment should be regarded as a form of partial insurance

against disease rather than as an absolute preventive. It may assist in reducing damage from such diseases as Rhizoctonia or Black Scurf, Common Scab, Blackleg and Ring Rot, though it should not be relied upon alone for the control of any of these diseases. It may aid in the prevention of seed-piece decay and thus improve the stand. It also may improve the yield. It is a sanitary measure that may be considered as one step in good farming practice in potato production. Most of the treatments so far used on seed potatoes contain either formaldehyde or mercury compounds as the germicidal agents. They are applied in liquid form. Wetting the tubers with water 24 hours before treatment has improved disease control in some cases.

Cold Formaldehyde Treatment. The solution used in this treatment is made by adding 1 pint of commercial formalin to 25 gallons of water. The tubers are soaked in this solution for 1-2 hours depending on their cleanliness, and then are spread out to dry. Especial care should be taken to see that they do not come in contact with dirty sacks or other sources of contamination after drying, since little protection is then provided. This treatment, though easy to apply, has definite limitations. It is not recommended for potatoes showing obvious infestation with Rhizoctonia. It should be applied only to uncut tubers.

Standard Mercuric Chloride Treatment. Tubers selected for seed and uncut are soaked for 1½ hours in a solution of mercuric chloride (corrosive sublimate) in water (4 ounces in 25 gallons). The solution is easily prepared by dissolving the crystals of the chemical in a gallon of hot water first and then adding this to 24 gallons of water, in a non-metallic container such as a wooden barrel. After soaking in this solution for 1½ hours, the tubers are drained, spread out in clean surroundings and allowed to dry. As the solution weakens with repeated use it is necessary to maintain its strength by adding ⅜ ounces of the chemical (dissolve first in hot water) for every four bushels of potatoes treated for 1½ hours. After each 1½ hour period of use add enough water to keep up the volume. If more is needed after four treatments it is well to make up a fresh solution. Both the crystals and the solution are highly poisonous if eaten by man or beast, so every precaution against this must be taken. It is well not to treat more tubers than are needed for seed, since tubers treated with this or any other mercury compound must not be eaten by humans or fed to livestock.

This treatment is time-consuming but it is one of the most satisfactory for seed infested with Rhizoctonia.

Acid-Mercury Dip Treatment. Mercuric chloride (corrosive sublimate) is used in this treatment also but in a somewhat different way than in the previous treatment. It is dissolved in acid rather than in water and the resulting solution after dilution with water is applied for only a few minutes. The first step in preparing the solution consists in dissolving 7 ounces of mercuric chloride in 1 quart of commercial hydrochloric acid. The second is to add this slowly to 25 gallons of cold water. Whole potatoes may then be treated simply by immersing them for 5 minutes in this final solution. If the tubers have started to sprout, a somewhat less concentrated solution should be used containing 5 ounces instead of 7 ounces of mercuric chloride. After treating 50 bushels of seed the solution should be discarded. Up to that point it may simply be kept up to volume with an extra supply of the original solution. Tubers should be dried quickly after treatment.

The same precautions are necessary in using this treatment as for the standard mercuric chloride treatment. It has the advantage of giving much the same results in a much shorter time so is more suitable for large scale treating, but injury may result if the tubers are not dried quickly.

Organic Mercury Treatment (Semesan Bel). This treatment as recommended by the manufacturers can be given in a still shorter time namely in about 1 minute. The chemical sold as an orange colored powder is dissolved at the rate of 4 lbs. to 25 gallons of water. The potatoes are dipped in this solution and held long enough to become thoroughly wetted which takes about a minute. Both whole and cut tubers can be treated, which is a considerable advantage. However, seed treated after cutting should be planted promptly. The solution should be discarded when about two-thirds of it have been used.

The chemical used in this treatment is poisonous but it does not corrode metals. It has merit particularly as a protectant for relatively clean sets.

Care of the Seed after Treatment

Cutting of the seed into sets provides an opportunity for further elimination of diseased tubers. It also may serve to spread the causal agents of certain diseases if present in the stock, e.g., the spindle-tuber virus and the ring rot bacterium. As has been pointed out before, one should discard at cutting time any tubers showing internal discoloration and should sterilize the cutting knife or change it for a sterlized one after cutting an obviously diseased tuber. Two practices may be

employed to protect the sets from contamination during and following the cutting process, namely treatment of the cut sets (see previous section on organic mercury treatment) and suberization.

Suberization refers to a healing process consisting in the formation of protective corky tissue over cut or wounded surfaces. The cut surfaces of the potato sets are vulnerable points at least until they heal. Fortunately, this healing process usually takes place quickly, but sometimes it is delayed and trouble may result. Satisfactory healing will usually take place in the soil in sets planted soon after cutting, provided the soil is not too wet, too dry, too cold or too hot. Suberization requires air (oxygen), moderately warm temperatures (60-70°F.) and a moderately humid atmosphere. If cut sets cannot be planted immediately in soil having these conditions, suberization may be encouraged by holding them for a few days in clean moistened sacks in a well ventilated place kept at 60-70°F. The sacks should be only half-filled and should be spread out so that the sets are not over four or five inches deep. They should be turned as necessary to separate any sets tending to stick together. After healing they should be planted or stored in a cool place.

It is important to use only clean sacks, pails or containers in handling seed potatoes at anytime but especially after they have been cut. Methods of sterilizing such equipment are given below.

Preparation of Soil

In order to reduce disease damage to a minimum, attention must also be given to the preparation of the soil. It should be prepared in such a way as to be as free as possible from active parasites and so as to otherwise induce vigorous growth of the crop. To this end potatoes should never be grown after potatoes but should be grown in a well-planned rotation as previously indicated. At the same time the moisture supply, the fertility and physical condition of the soil should be maintained in the best possible state for potatoes.

Protection of the Growing Crop

Because certain disease-producing agencies may multiply in the growing crop, it is advisable for the grower to be always on guard and to take such steps as may be necessary and feasible to prevent this. Eradicating diseased plants and protecting the crop by dusting or spraying with fungicides and insecticides are the principal preventive measures that are employed.

Eradication here refers chiefly to the roguing out and destruction of diseased plants particularly those affected with virus diseases. This is more feasible in crops intended for seed, but is of value in crops intended for other purposes as well. In this way reservoirs of inoculum are removed and prevented from contaminating other plants in the stand.

Spraying or dusting of potatoes for the prevention of foliage diseases has not been commonly practised in Alberta due

Spraying potatoes for the control of foliage diseases and insects by means of a high-pressure sprayer. After R. Bonde.

largely to the relative freedom of our crops from late blight, the most serious foliage disease of the potato. Late blight has, however, appeared recently and done some damage to potatoes in wet seasons in central and northern Alberta. It is well therefore to be prepared to combat it should it develop in a crop. The same procedure used for the control of this disease is also effective against early blight, a less destructive foliage disease but one which is more common in Alberta. In eastern Canada foliage diseases are commonly prevented by spraying with Bordeaux mixture. However, dusting with a copper-lime dust is a reasonably effective substitute and is likely to be a more feasible method for Alberta growers most of whom lack spraying equipment. An insecticide such as arsenate of lime can be added if necessary, and thus protection from the potato beetle may be provided at the same time. The mixture without the insecticide should include 20 pounds of finely ground dehydrated copper sulphate and 80 pounds of

Dusting machine with trail sheet as used in insect and disease control. After H. W. Dye and A. G. Newhall.

hydrated lime; or with the insecticide, 12 pounds of finely ground dehydrated copper sulphate, 8 pounds of arsenate of lime and 80 pounds of hydrated lime. Smaller amounts may be made by using the constituents in the same proportions. The dust should be in a finely divided state and should be applied in the evening or early morning when the plants are wet with dew and there is little or no wind. In the case of small patches it may be shaken on the plants from loosely woven sacks but for large fields a mechanical duster will be necessary. The operator should wear a dust mask to avoid inhaling the dust. The first application should be made when the plants are about eight inches high if blight threatens to become prevalent. Additional applications at intervals of a week or ten days should follow if conditions continue to remain favourable. When in doubt advice should be obtained from the nearest agricultural experimental station.

Among newer dust and spray materials are several fixed copper fungicides lacking free lime and the organic preparation Dithane. Some of these, especially when combined with an insecticide such as DDT, have recently shown considerable promise when used on potato foliage.

Dusting or spraying for the control of insects such as aphids and psyllids should indirectly reduce disease where these insects are present. Procedures are dealt with in the section on insects.

Cultivation of the growing crop should of course keep it free from weeds and this indirectly may assist in disease prevention as is pointed out elsewhere.

Precautions in Harvesting

As has been previously pointed out, care at harvesting time may avoid much loss later. Commercial potatoes should be allowed to mature as much as possible without endangering them from frost and disfigurement by Rhizoctonia. The black bodies of the latter fungus increase in abundance on the tubers as they mature and hence earlier harvesting may be necessary if this disease is prevalent. Usually the quality of table-stock increases with maturity and the susceptibility to bruising decreases. Even padding of digging machines and containers may be advisable in order to reduce mechanical injury.

Time of digging may often be adjusted to reduce possibility of damage from factors such as frost, and late blight. For instance, if the latter has been present it may be wise to let the tops die down or to destroy them by spraying with an herbicide such as Sinox plus ammonium sulphate before digging; also to treat the freshly dug tubers for five minutes in a formaldehyde solution (1 pint formalin in 25 gallons of water) to reduce the amount of tuber-rot in storage, according to authorities of the Maine Agricultural Experiment Station. If possible, dry, warm weather should be chosen for harvesting. After digging, enough time should elapse for the potatoes to dry thoroughly before they are placed in storage. Partially rotted tubers or ones otherwise unsuitable for storage should be discarded at picking time.

In the case of seed potatoes, early digging has proved a promising measure for reducing damage from virus diseases such as leaf roll and mosaic and from the bacterial ring rot disease, in recent studies made in Maine. It is possible that more advantage of this practice could be taken in Alberta in the production of seed potatoes.

Use of Disease-Resistant Varieties

Wherever disease-resistant varieties can be used to advantage, this should be done. Scab, late blight and mosaic diseases can already be combatted to an appreciable extent by this means. More satisfactory varieties possessing disease resistance will no doubt become available in the near future and their use will reduce the disease hazard still more.

General Sanitary Measures

Cleanliness is important at all stages in potato production. At no time should potatoes be exposed to infestation if this can be avoided. The seed should be handled in clean, preferably sterilized containers. A solution of formalin (1 pint to 25 gallons of water) is useful for sterilizing sacks, tools, etc. They may be soaked or thoroughly washed with this chemical. The

seed tubers should be treated as previously described to destroy any inoculum carried on them. The sets should then be sown in the cleanest soil available, preferably in soil which has not produced potatoes for several years. The crop should be isolated as far as possible from other potatoes. Weeds should be controlled. Plants affected with virus diseases should be dug out and destroyed. The field should be plowed after harvest and heaps of potato tubers or old tops should be buried or destroyed before a new crop is planted. The storage quarters should be disinfected before the new crop is brought in. This is best done after it has been entirely emptied and thoroughly cleaned. The floors, walls, etc., should then be sprayed or sprinkled with a solution of bluestone (copper sulphate) made in the proportions of 1 pound bluestone to 10 gallons of water.

Storage Conditions

The control of environmental factors in storage is in large measure necessary in order to prevent decay. Low temperature, good ventilation, and moderate humidity are the main requirements needed for this purpose. These have been discussed in a previous section.

Insects Attacking Potatoes and Their Control

by

E. H. Strickland

Potato Beetle (Leptinotarsa decemlineata Say)

This insect, normally, is confined to the southern part of Alberta. In recent years, owing to unusually dry falls and slight frost penetration in the soil during the winter, it has spread to north of Edmonton. With the return of more normal seasons, it can be safely assumed that it will disappear from all districts much to the north of about Olds to Stettler and Coronation. South of this line, however, control measures may be required annually.

The overwintering black-and-yellow striped beetles cause relatively little damage in the spring. They fly freely and lay batches of yellow eggs on the under side of the leaves. From these hatch far more destructive pinkish grubs, which may entirely devour the leaves unless they are destroyed by poisoning.

Control by dusting.

Formula:—Paris Green or Calcium arsenate 1 pound
Fine "Dust" ..... 10 pounds

Potato Beetle feeding on potato leaves. The picture shows one adult (striped) and several grubs. After A. G. Tolaas.

Cheap flour is the best dust to employ because it sticks to the leaves better than does anything else. However, hydrated lime, or the fine dust which can be collected from a well-travelled dirt road is a satisfactory substitute.

Application:—Thoroughly mix the poison with the dust. For large fields a hand or power "dusting machine" is desirable. In a garden a satisfactory application can be made by placing some of the dust mixture in a small bag made of some loosely woven cloth, such as gunny sacking, and jarring it over the plants until the upper side of the leaves is lightly covered with a scattering of dust.

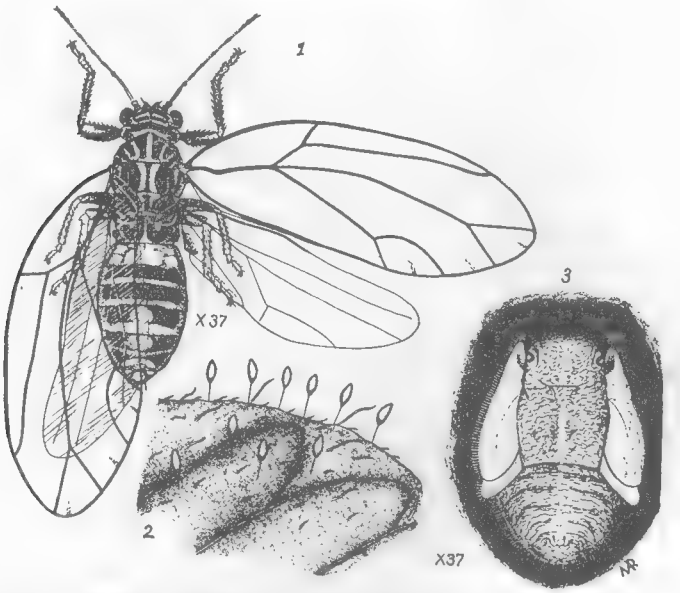
Control by spraying

Formula:—Paris Green—2 ounces; or Calcium arsenate—4 ounces. Water—5 gallons.

Application:—A fly-sprayer will treat a few plants, but a knapsack sprayer is desirable for large gardens or fields.

Repetition of Treatment

Potato beetles fly and lay eggs throughout the summer. Dusting or spraying will kill any beetles or grubs which feed subsequently on the leaves which were already developed at the time of application but neither can protect later growth. Either should, therefore, be repeated, as necessary, every three or four weeks during the growing season.



Potato and Tomato Pysllid (1) adult (2) eggs (3) nymph or immature form. After G. M. List.

Potato and Tomato Psyllid (Paratrioza cockerelli Sulc.)

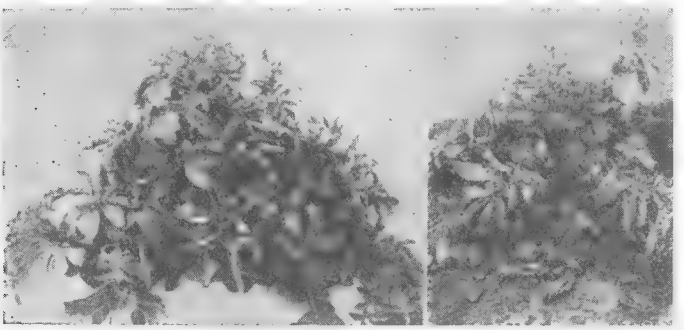
In the early stages of their development, these are very small greenish-yellow insects somewhat resembling plant-lice, though they are more flattened. They are found, chiefly, on the under side of the leaves. When full grown they are winged and they jump and fly actively. These are not native to Alberta and it is doubtful whether they can overwinter here in the open. Certainly, the greatest danger to the potato grower here is from flying Psyllids which escape in the spring from greenhouses where they have lived through the winter on tomatoes and related plants. Up to the present, the most serious damage from Psyllids has been confined to potatoes grown to the south of Red Deer.

Damage

The actual food consumption by Psyllids, which suck sap from the leaves and stems, causes little damage. Unfortunately, a very small number of them feeding on a potato plant may produce a disease, called "Psyllid Yellows." This appears to be due to some poisonous material which is always present in their saliva.

Recognition of Psyllid Yellows

The younger leaves may assume a yellowish, or, more frequently, a purplish tinge especially in the basal parts of the



Potato plants affected with Pysllid Yellows. After Alberta Department of Agriculture Bulletin 22.

leaflets which tend to roll upwards. Later in the season, the entire plant appears to be stunted and bushy.

An early infestation may result in no tubers forming, while plants not attacked till midsummer may produce large numbers of very small tubers or ones which are badly malformed and of no commercial value. A brown flecking or net necrosis may develop in the flesh of tubers on affected plants.

Control

The stomach poisons recommended for the control of Potato Beetles are *absolutely useless* for the control of insects such as Psyllids and Plant-lice. The insects have *sucking* mouths and they can be killed only by poisons which come into *actual contact with their bodies* at the time of application. Since most of these insects live on the under side of the leaves, the poisons must be applied by a method which will reach them here.

Dusting. This is simpler and is more effective than spraying.

"Dusting Sulphur" not coarser than 300 mesh is very effective.

Application:—A dusting machine, either hand- or power-operated, is almost a necessity in order to drive the dust to the under side of the leaves. Several hand-operated bellows or fan type dusters are obtainable for gardens or small fields, while for larger fields traction or power-operated dusting machines are a good investment despite their initial cost.

In all dusting operations for controlling Psyllids a "trail sheet" consisting of factory cotton or other cheap cloth, should be used to insure that the dust will be distributed on the under side of all leaves. This should be about 15 feet long and wide enough to overlap the row or rows being dusted. Its leading edge is tacked along a light wooden bar to which the nozzle of the duster is attached in such a manner that the dust is

delivered under it. When a hand operated duster is being used, the operation can be simplified by inserting a length of rubber hose between two sections of the delivery pipe in order that the nozzle may be directed backwards and so trail *behind* the operator.

Spraying. Formula: Lime Sulphur. If dry: 1 pound to 8 gallons water. If liquid: 1 part to 40 parts of water.

Application:—Must be very thorough. Every Psyllid must be wetted.

In small gardens a fly-sprayer is effective, provided the lower sides of the leaves are exposed by pushing the plants over to one side and then to the other during the application.

For larger gardens or fields a knapsack, or preferably a power sprayer, is a necessity. It should develop a pressure of 250 to 300 pounds and its nozzle or nozzles must be held or so placed that the bulk of the spray is directed *upwards* from below the level of the leaves. Some poison must, however, be applied to the upper surface of the leaves.

Frequency of Treatment. Whether control is to be effected by dusting or spraying, the first treatment must be made when the plants are about six to eight inches high. This should be repeated about three times at intervals of approximately two weeks.

Plant-lice (Aphids)

There are several species which attack potatoes. As in the case of Psyllids, the greatest damage arises from diseases which result from their feeding. The most serious of these are Leaf Roll and Mosaic. Unlike Psyllid-produced yellows, however, these diseases are caused by viruses, which are infectious principles that are introduced into plants with the saliva.

The most injurious plant-lice to potatoes overwinter, in the largest numbers, on cultivated roses. Partly for this reason, diseases caused by aphid-borne viruses are most prevalent in gardens or fields in or near our larger towns and cities.

Control

Control measures are similar to those employed for Psyllids, though different materials are used. As in their case, only the insects actually touched by contact poisons can be killed.

Dusting. A 2% nicotine sulphate dust has proved to be the most satisfactory control. This can be obtained already mixed but can also be "home-made" if care be taken to obtain a thorough mixing of the ingredients.

Formula:—Nicotine sulphate ..... 1 pound
Hydrated lime ..... 19 pounds

Place the lime on a non-absorbent surface. Add the nicotine, a little at a time, and mix well. Rub the mixture through a piece of fly-screen with a stiff brush. Repeat this until it is of a uniform colour.

Application:—Employing a "trail sheet" apply in exactly the same manner as that recommended in dusting for Psyllid control.

Spraying. Dissolve 2 pounds of laundry soap in 40 gallons of water and add ⅜ pint of nicotine sulphate. Do not prepare more than will be used in one day. Apply as directed for controlling Psyllids with lime sulphur.

Frequency of Application. Plant-lice can increase in numbers very rapidly. Closely examine the plants every two weeks. If small colonies of plant-lice are observed at any time, repeat the treatment without delay.

Wireworms

Several species of these "click-beetle" grubs attack potatoes. In gardens or fields in which these are numerous, they may seriously injure the tubers by tunnelling into them.

Wireworm injury to potato tubers. After E. L. LeClerg.

Control

The employment of chemicals for reducing the number of wireworms in the soil is, at present, too expensive and laborious to be recommended under Alberta conditions. The best course to adopt is that of selecting a piece of ground for potato growing in which there is reasonable assurance that wireworms are not very abundant. Avoid ground in which any form of grass, including grain crops, has been grown

during the past three to four years. If this is impossible, select ground in which oats have been grown fairly frequently in preference to wheat, and where a really clean summer-fallow has been regularly practised.

DDT for Controlling Potato Infesting Insects

Although the employment of this material is still in somewhat of an experimental stage, it appears to have definite advantages over many of the earlier recommended contact insecticides for the control of insects which attack potatoes. These insecticides kill only those insects which actually come into contact with them *at the time of application*, whereas DDT has a lasting effect. It kills many insects which may not come into contact with it for up to a week or more after it has been applied to potato plants. It does not, however, give the lasting protection to plants of three or more months which is afforded in buildings where it has been used for the control of houseflies, etc.

Though it is an effective stomach poison, it is rather too expensive for replacing Paris Green or calcium arsenate for the control of Potato Beetles when these, alone, infest the plants, but it can be used to replace any of the contact materials which are recommended above for the control of Psyllids and Plant-lice.

Dusting with DDT. Use any commercial 3% DDT dust. Apply with a trail sheet as recommended in the discussion of dusting for Psyllid control.

Spraying with DDT. This usually is less effective than dusting.

Formula:—Any commercial 10% mixture of DDT in a *wettable* carrier, such as Prophyllite ..... 4 pounds
Water ..... 100 gallons

Application:—Take the precautions already given to assure that the spray reaches the under side of all the leaves.

Frequency of Treatment. For the present, it is suggested that treatments with DDT be made as frequently as has been recommended for the employment of other insecticides. It is, however, probable that any two-week interval between treatments can be safely extended to about three weeks.

Weeds in Potato Fields and Their Control

For best results with potatoes they should be planted on clean land. If the land is polluted with weeds, excessive cultivation will be required to control the weeds. This may be detrimental to the potatoes. Also if wet weather prevails the weeds are likely to get ahead and crowd out the potatoes.

Sometimes potatoes are planted on weedy land, simply to get some return from the land while it is being cleaned. Here, however, the main object is weed control rather than to get a maximum yield of potatoes. Weeds compete with potatoes for moisture and soil nutrients and thus reduce yields. They also serve to increase the insect and disease hazard. It is therefore important to plant potatoes on clean land and to cultivate them at intervals to keep them free from weeds. Harrowing before emergence and alternate light hilling and harrowing soon after emergence will greatly reduce the amount of later cultivation necessary for weed control.

A clean, well kept field of Alberta potatoes. After Alberta Department of Agriculture Bulletin 22.

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